



1988

Descriptive Analysis of Precollege Educational Activities at the Department of Energy Facilities

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DESCRIPTIVE ANALYSIS OF PRECOLLEGE EDUCATIONAL ACTIVITIES
AT THE DEPARTMENT OF ENERGY FACILITIES

Juanita Thomas

A Dissertation Submitted to the Faculty of the Graduate School
of Loyola University of Chicago in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

May

1988

ACKNOWLEDGMENTS

I wish to acknowledge the support and guidance received from each of the members of my Dissertation Committee: Dr. Max A. Bailey, Director, Dr. Philip Carlin, and Dr. L. Arthur Safer. Special recognition is given to Dr. Bailey for his encouragement, counsel, critique and support.

Special recognition is extended to Dr. Frank Vivio who contributed to the insight and understanding of the Department of Energy's philosophy and practices.

I would also like to thank my husband, Charles, and daughter, Tori, for their support, patience, and encouragement through the completion of this study.

VITA

Juanita R. Thomas, an Assistant to the Laboratory Director of Argonne National Laboratory, and Director of Precollege Education Programs, was reared and educated in Milwaukee, Wisconsin.

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Juanita was awarded a National Science Foundation Fellowship and is a member of American Women in Science, Sigma Xi, and the American Association for the Advancement of Science.

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CHAPTER I

INTRODUCTION

The key role of the Federal Government in educating and assuring an adequate supply of scientists and engineers has been acknowledged since the close of World War II (Moe, 1945). It was reemphasized in a series of reports from the President's Science Advisory Committee in the immediate Post-Sputnik era (1958 - 1962) which, according to one analyst "... articulated the national need for greater numbers of scientists and engineers..." (Fallows, 1983).

In 1983, six nation-wide commissions including the National Science Boards (1983), National Commission on Excellence in Education (1983), Task Force on Education For Economic Growth (1983), College Entrance Examination Board (1983), Twentieth Century Fund - Task Force on Federal Elementary and Secondary Education Policy (1983), and Boyer,(1983), published reports recommending reforms for our educational system.

The conclusions of these bodies were similar - that there are serious problems in precollege science and mathematics education which threaten our economic future and national security and the ability of all citizens to function in a high-technology society. These reports

pointed out that many students leave high school without adequate preparation in science and mathematics.

Scientists and engineers represent only 3 percent of the national work force, but are considered by many to be a crucial element in the nation's efforts to improve its economic competitiveness and national security. The pool of talent from which the Nation's scientists and engineers is drawn is largely formed in high school. The scientific pipeline begins in seventh and eighth grades, when students are first able to elect mathematics and science courses. Few high school graduates who were enrolled in mathematics and science courses in high school go on to major in science or engineering in college; fewer of these go on to get any science or engineering degree, let alone a doctorate; and fewer yet then proceed to get science or engineering jobs. Leakage from the science and engineering pipeline is only outward, never inward. The pipeline only narrows (Berryman, 1983).

State school administrators have responded to the problem. Nearly every state has launched programs to improve science and mathematics in several areas, including upgrading course requirements and offerings; improving the content and structure of current offerings; enhancing teacher qualifications and training, and improving the subject knowledge of teachers in areas in which they are certified to teach (NSF, 1985).

The current Reagan Administration has reaffirmed the

Federal commitment to the education and training of scientists and engineers, stating that:

... we have to make sure that we derive educational and training advantages from Federally supported research - because all of our expectations and opportunities for industrial progress call for a growing supply of skilled technical personnel (White House, 1983).

One of the fundamental premises of President Reagan's policies is that the nation's economic health and well-being are closely related to the strength, diversity, and growth of our scientific and technological research base. This base in turn is heavily dependent upon the continuing contributions of university and scientists and engineers in developing new knowledge and on the training of young people for future careers in the nation's research and development programs.

The Department of Energy (DOE) being both a "user" and "developer" of science manpower and under federal control, is concerned with the quality of precollege education as well. The Department of Energy provides approximately \$750,000 each year in either direct support of university research or through the Department's national laboratories for a wide range of activities benefitting university research and development programs (DOE, 1986).

Because of its concern with precollege science programs, the Department of Energy has, through many of its

individual facilities provided assistance to local schools, including providing opportunities for precollege science teachers to work at the laboratories during the summer.

The Department of Energy, as a mission-oriented research and development agency, historically has had important, complementary responsibilities in ensuring that adequate supplies of highly qualified, well-trained scientific and technical professionals are available to meet current and future research and development needs. The Department as a major "user" of scientific and technical talent, also has taken steps to contribute to replenishing the nation's scientific and technical manpower pool.

The Problem

Prior to the issuance of the national reports outlining the problems in precollege science and mathematics education that appeared to threaten our economic future and national security, the Department of Energy's facilities were already involved in precollege education. These programs, informal in nature, were funded by the individual facility's operating budget. These activities were not included in the Department of Energy's mission or budget and were offered on an ad hoc basis. As a result, no accurate documentation of the full range of DOE precollege activities existed.

An announcement of an "Apprenticeship for Minority High School Students" program by President Carter (1979),

was the first attempt to acknowledge precollege education as part of the DOE's mission. The purpose of that program was to strengthen the nation's and government's effort to recruit and sustain minority students in science and engineering.

Since 1979, the number of DOE precollege activities has increased tremendously. The reasons for increased participation in precollege activities at the DOE facilities are varied - not the least of which was President Reagan's pre-election (1983) interest in the status of science and mathematics education in the elementary and secondary schools.

The DOE facilities responded to the needs of precollege science education in various ways. With the increased involvement came increased concern as to what the role of DOE should be in precollege education and whether the Department should be involved with this level of education at all. In an attempt to clarify the role of the Department's facilities in precollege education, Argonne National Laboratory convened a Conference (1984) to address these concerns. A number of issues and questions surfaced during the Conference. One that generated a great deal of discussion was "What particular strengths could the DOE facilities bring to the important issue of improving the quality of science education at the precollege level?" It was argued that the DOE facilities have missions designed to carry out activities on behalf of the nation and

that, in fact, at many of the facilities the mission had already become too broad, if not too diffuse. One view was that for the Laboratories to take on yet another task, one in particular where the facilities may not have anything unique to offer, would be to further diffuse the mission while not making a real contribution to the very important problem (ANL, 1985).

In response to these concerns, Walter Massey, Director of Argonne National Laboratory replied:

I do believe that DOE can contribute significantly to improving the quality of science education. I believe the facilities have particular strengths that are either not possessed by other institutions or that are not possessed in the same degree of strength. The problem is to determine more precisely what we, the Department of Energy Facilities, can bring to this issue without unnecessary duplication or diminution of our primary missions (ANL, 1985).

After prolonged discussion on the role of the Department in precollege education, the Conference participants agreed upon the following suggested guidelines for precollege activities:

1. The Department of Energy facilities should focus on programs that revitalize precollege teachers through having them spend internships with laboratory scientists during the summer. Institutes and in-service training should be conducted throughout the academic year.
2. The Department of Energy facilities' scientists

should become involved in the schools as partners with teachers. They should work cooperatively with teachers to develop curricula as well as teaching aids, both at the high school and elementary levels.

3. The Department of Energy facilities should collaborate with university education departments for two reasons - to provide assistance in training future teachers, and to work as collaborators in developing curricula and teaching aids for the precollege teachers

4. The Department of Energy facilities should conduct an active outreach program. Each facility should develop cooperative relationships with its surrounding communities, through local school boards and other community organizations to clearly define needs and to contribute to the gaining of scientific literacy among the general populace.

5. The Department of Energy facilities should not limit its involvement with students to those who have been identified as academically talented. All students should be the focus of some selected activities.

The Conference provided a forum for a unique set of scientists, engineers and educators to focus on defining productive and useful roles for the DOE Facilities in their efforts to meet the needs of precollege science education.

Purpose

The purpose of this study was to assess the full range of precollege activities conducted at the Department of Energy Facilities. The current study was guided by the following research questions: 1.) What policies or mandates served as the catalyst for initiating precollege science activities at DOE Facilities? 2.) Which DOE Facilities sponsor precollege science education programs? 3.) What is the scope of the precollege science programs sponsored by the DOE Facilities? 4.) What are the sources of precollege support funds and how are they used? 5.) To what extent do the DOE Facilities agree on the appropriateness of the guidelines developed during the 1984 DOE precollege Conference.

This study provides a synthesis of the current precollege science activities being conducted at DOE facilities. It is hoped that this information and other data collected from the study will be of value to the Department of Energy and the national administration as they encourage other institutions not primarily involved in education to become active participants in precollege science education programs.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

A search was conducted in order to discover whether or not a study had been previously undertaken which examined the status of precollege science and mathematics education programs at the Department of Energy Facilities. The following resources were used: 1) Educational Index; 2) Current Index to Journals in Education; 3) Resources in Education (ERIC); and Reader's Guide to Periodical Literature. Upon investigation of these sources, it was determined that this study has not been previously done. However, each year since 1983 when the six nation-wide commissions issued reports about a national need to implement reforms in the educational system; more and more interest in precollege science and mathematics issues has been demonstrated by researchers resulting in a large body of literature in this area.

Due to the lack of direct research on precollege programs at the Department of Energy (DOE) Facilities

Chapter II presents the related literature and research, which looks at the importance of science and engineering talent to the Nation; the effects of changing demographics on science education; the current status of science education; minority and female involvement in science education; science education intervention programs, and the professional scientists role in education.

Importance of Science Talent to the Nation

Two themes emerge in the literature regarding the importance of scientific talent to the nation: the advancement of science and technology and international competitiveness. The National Science Board (1985) indicated the importance of scientists serving as tools for advancing the understanding of nature, for pursuing national goals, and for attacking many of the problems of United States and world society. Scientists and engineers are also identified as crucial elements in the Nation's efforts to improve its economic competitiveness and national security (U.S. Congress, House, 1985; Science Indicators, 1985). The importance of the the quantity and quality of engineers and scientists to the U.S. economy is stated by the National Science Foundation (NSF):

The nation's economic vigor and quality of life, as well as military security, are strongly dependent on the number and quality of the engineers and scientists which the U.S. has available both now and in the future. Thus, the health and well-being of the system which educates American youth in engineering and science, and enables the practicing engineer and scientist to stay at the forefront of rapidly developing fields of science and technology is a crucial part of the nation's science policy (NSF, 1985).

Although the concerns expressed by Izzak Wirsup (1976) to the Carter Administration about the United States international competition for technological leadership being threatened by the low quality of the Nation's educational system brought a review of science and engineering education policies (Arbolino, 1985), the same concerns continue to be expressed ten years later by other writers:

A workforce trained in mathematics, adaptable, inventive and able to pursue the research and innovation that the United States has shown in the past is the only way for the nation to keep ahead of other countries (Bloch, Salley, 1986).

Arguing that the quality of life and the assets and liabilities of our society depend a great deal on modern science, Hurd (1986) states:

"Scientific and technological endeavors are major factors in framing social, economic, and political policies in the U.S. and the world."

These concerns and others about the United States maintaining the lead in science and technology appear

frequently in the literature. The United States is constantly chided for sinking into the same state of complacency that preceded the earth-orbiting satellite by the Soviets in 1957:

Thirty years later, in 1987, the United States faces a similar crisis. ... Nations that only a few years ago we considered to be economically and technologically inferior have now surpassed us in many areas... (Jennings, 1987).

Demographic Trends

The effect that the changing nature of the Nation's population will have on the scientific workforce is frequently examined in reports focusing on science and technology. Demographic and other trends predicted to occur over the next 20 to 30 years are expected to have a significant impact on the size and make-up of the science and engineering workforce (Manpower Comments, 1984).

Reports in the literature state that the demand for scientists and engineers will remain strong into the next decade if the Nation expects to improve its industrial advances and academic leads. At the time this demand will be growing, the number of Americans qualified for science and engineering careers may be declining (Nurturing Science and Engineering Talent, 1987; OTA, 1985)

Assuming the current growth in demand in industry continues, and that demand in academe increases toward the end of the 20th century, as many faculty retire, the demand

for scientists and engineers will remain strong into the next decade. However, at the same time that demand is growing, the number of Americans qualified for science and engineering careers may be declining. (OTA, 1985)

With an expected decline of more than 25% by the year 2000 in the number of 22 year-olds and assuming the same porportion of young people choosing to enter science and engineering, fewer baccalaureates will be awarded in these fields (NSF, 1987). To maintain the 1985 level in the mid 1990s in porportion of 22 year-olds that attain natural science and engineering degrees, the degree award rate would have to rise to 6.1% of all 22 year-olds from its 1985 level of 4.9% (Manpower Comments, 1986). There is also much concern about the declining interest by U.S. students, particularly men, in pursuing a doctoral degree in science and engineering (Science Indicators, 1985).

A trend noted by Hodgkinson (1983) that an increasing porportion of the college age population will be made up of racial or ethnic minorities brought forth concerns about the developmental needs of minority students (McNett, 1983) and concerns about policies to promote equality of opportunity for women and minorities to ensure their participation in science and engineering careers (OTA, 1985). A report submitted to Congress (1981) by the Director of the National Science Foundation proposed a

comprehensive, continuing program at the Foundation to promote the full participation of minorities and women in science and technology (NSF, 1981). But the report contained neither budgetary nor legislative recommendations and attempted to rationalize budget cuts in programs created in the 1970s for women and minorities (Malcom, 1984).

In the absence of executive branch leadership the American Association for the Advancement of Science (AAAS) recommended that several steps be taken by the Federal Government to support programs to improve the quality of precollege education in science, mathematics and technology for minorities, women and disabled student populations (AAAS, 1985).

Status of Science and Mathematics Education

Concerns about science and mathematics education during the past few years stimulated a number of efforts to provide better data to aid in understanding the status of science and mathematics education, to guide policy initiative to improve the situation, and to track the effects of those initiatives (Gilford, 1986).

Many studies have been conducted assessing the status of course offerings, curriculum content, educational attainment, and gender and race differentials in science

and mathematics education at the national and international levels. The findings of some of these studies are presented here:

Science offerings in high schools leave a lot to be desired. A survey of the science course offerings in the nation's 24,000 high schools revealed that 7,100 offer no physics courses, 4,2000 offer no chemistry courses and 1,900 offered no courses in biology (West, Diodata and Sandberg, 1984; Grand and Snyder, 1983; NSTA, 1987). Data on course enrollments for mathematics also appear in the literature. National estimates of the number of courses offered in public secondary schools in science and mathematics for 1972-74 were produced from data collected by the National Center for Education Statistics in 1975 (Osterndorf, 1975), and in 1976, and 1981 (Welch, Harris, Anderson and Mullis, 1981). The percentage of states that require less than one year, one year, and more than one year of mathematics, science and social studies courses for high school graduation and comparable information on state and district guidelines for time to be spent on these subjects for grades K-6 (Weiss, 1978, NSF, 1979) is also available. The special value of these latter findings is that the data gathered can serve as the base year for measuring change, since the study was repeated with little change in 1985 (Weiss, 1985).

Collection of data on the academic differences between races also occurs frequently. Whites still outscore minorities on science and mathematics assessment tests (Grant and Snyder, 1983). An attempt to explain the consistent reductions during recent years in the size of average mathematics achievement score differences between white and black students was conducted (Jones, 1984). Based on SAT quantitative test scores during 1976 to 1983 and the National Assessment of Educational Progress assessments in 1973, 1978 and 1982, the study reported that the average SAT mathematics scores for white students declined by 9-scale points over an 8-year period, while average scores for black students increased by 15 scale points. Black and Hispanic 17-year-olds scored significantly lower than their white counterparts on the national mathematics assessment in 1982. The national norm was 60.2%. White students scored 63.1%, blacks scored 45.0% and Hispanics scored 49.4% (Education Commission of the States, 1983). The study concluded that the most effective way to improve mathematics achievement levels and to reduce further white-black achievement differences is to encourage further enrollment in mathematics courses in high school (Science Indicators, 1985)

Information related to the gender gap is also found in the literature. In response to the manipulative process

lab test given to both 5th and 9th grade students, girls continued to underperform boys on the written test, generally by 5 to 7 percent. But in the manipulative process test, girls and boys achieved equally. One implication of this finding is that teaching science by way of process tasks may be a way to encourage girls to study science (IAEEA, 1985).

While students intending to major in science or engineering score significantly higher than other students on the Scholastic Aptitude Tests (SAT) on both the science and mathematics tests, national SAT score means for all students declined during the ten-year period, 1975 to 1984 for students intending to major in science or engineering (Carnegie Foundation 1983; Educational Testing Service, 1985).

There is great concern for the vast numbers of high school students who take very few mathematics or science courses (Jones, 1984; NCEs, 1984; Vetter, 1987). Findings that only one-third of students in grades 10-11 are enrolled in any science course has been particularly alarming (NSTA, 1987; Science Indicators, 1985). The sophomore biology course is currently the last science course taken by about half of all U.S. students, and geometry is their last exposure to mathematics (NSF, 1985). Expressing concern about the ability of students to function without a solid foundation in math Izzak Wirszup states:

"Not only do they lack a solid foundation for future training, they cannot even apply basic mathematics and science to simple jobs "(Wirszup, 1985).

If manpower shortages do appear in the 1990s, when the total number of high school graduates will drop sharply, it will take years to boost the number of students with enough background for college training programs. Even mild shortfalls could create a drastic shortage of high school mathematics and science teachers. Well-trained teachers for these subjects are already in short supply (NSTA, 1982; NCES, 1982).

International Comparisons

Reports in the literature tend to show that in direct contrast to other industrialized countries, there is a declining emphasis on science and mathematics in the U.S. (NSF, 1982; Wirszup, 1981). Even the most academically gifted and science oriented students in the U.S. consistently perform less well in tests than students in Japan, England and other countries (Hurd, 1982; Gardner and Yager, 1983; Stevenson, Lee and Stigler, 1986). U.S. students correctly answered about 41% of test items in chemistry and 44% in biology and physics. In other countries, performance ranged from 48% for Japanese students in biology to 73% for English students in chemistry (Husen, 1983).

Other comparisons of the U.S. science and mathematics education programs with those in other countries show that in many European countries, biology, physics and mathematics are taught concurrently for the last 2 or 3 years of secondary school, while in the U.S., one-half of all high school graduates have taken no math or science beyond 10th grade, (Gardner, & Yager, 1983) and the introduction of science and mathematics occurs much earlier in the Soviet Union's precollege systems (Ailes and Ruschin, 1982).

International data regarding the international education situation were also collected from the teachers. In the United States, the data were collected from 7,000 eighth grade students and 5,000 students enrolled in twelfth grade mathematics, and from teachers from approximately 500 classrooms in about 250 public and private schools. The study collected data from teachers on teacher coverage of the various content areas by asking questions from which it was possible to report opportunity-to-learn (OTL) measures for material "taught this year" and "taught up to and including this year." The OTL data indicated an overall lack of topical emphasis, in arithmetic, algebra and geometry in the U.S. In addition, within these topics there is a large amount of "between-classroom" variation of coverage that reflects marked inequalities of opportunities for students across the United States to learn substantial

mathematical content (Travers, 1986). OTL measures are of particular importance in cross-national studies because of the variation among countries in the mathematics curriculum (Crosswhite, Dossey, Swafford, McKnight, and Cooney, 1985).

Undergraduate Education

The Nation's colleges and universities play a major role in U.S. science and technology. Since the baccalaureate is the entry level degree to a scientific or engineering career, undergraduate science, mathematics and engineering education have been the subject of some research. Reports about the quality of undergraduate education are common among precollege science education literature. Problems of quality, have developed during the past decade in the infrastructure of college-level education in the U.S. in these fields according to the National Science Board Task Committee on Undergraduate Science and Engineering Education (1986). According to this committee the most serious deficiencies are in laboratory instruction, faculty and curricula.

Faculty members are often unable to update their disciplinary knowledge continuously and maintain their teaching skills, and are largely unable to make skilled use of computers and other advanced technologies. Courses and curricula are frequently out-of-date in content, unimaginative, poorly organized for students with different interests, and fail to reflect recent advances in the understanding of teaching and learning (NSB, 1986).

Other data indicate that the support from all sectors for undergraduate education in science and engineering is inadequately responsive to either its worsening condition or the national need for its revitalization and improvement (NSF, 1986), and the nation's top liberal art colleges must invest \$1 billion more than current commitments over the next decade if they are to maintain and improve their present strong position in basic science (Future of Science, 1986).

Precollege Teachers

Precollege science and mathematics teacher shortage has been the focus of many surveys. According to the literature a potential shortage of scientists, engineers and technicians would be exacerbated by a decline in precollege mathematics and science teachers. There is evidence of a shortage of qualified mathematics and science teachers in the secondary schools and some diminishing of quality (Vetter, 1983).

The result of surveys of 50 state science supervisors in 1980 and 1981 indicated critical shortages of physics, mathematics and chemistry teachers in at least 35 of the states (Howe and Gerlovich, 1982). A near-critical shortage of teachers in mathematics, physics, chemistry and computer fields was reported in 1980 and 1984 (Akin, 1980, 1984).

A survey of college and university placement officers found that between 1971 and 1980, students enrolled in practice teaching courses in mathematics declined fourfold and science threefold, and only half of these student teachers ended up in teaching jobs. The survey also found that almost 25 percent of those currently teaching secondary school mathematics and science at that time planned to leave after five years (Shymansky & Aldridge, 1982).

The latest report from the Association for School, College and University Staffing (1986) indicates that the following fields continue to have a shortage of teachers: mathematics (4.1 teachers per thousand); science (3.9 teachers per thousand), and computer (2.8 teachers per thousand). These fields have the most demand for qualified teachers. Those fields with some surplus include elementary, social science, art and health education (ASCUS, 1986).

Admitting that the reasons behind the decline in quality and number of teachers are complex, the National Science Board in 1983 stated that "substantial efforts" must be made at three levels:

- (1) the skills and understanding of teachers must be upgraded;
- (2) the training of incoming teachers must be improved;

(3) persons who are qualified to teach mathematics, science and technology must be found from "non-traditional" sources (NSB, 1983).

The shortage of traditional candidates entering math and science teaching has received considerable public attention. The data show disturbing trends; (a) between 1971 and 1980, there was a 79% decline in the number of students pursuing teaching degrees in math and a 64% decrease in science (Graham & Fultz, 1986).

The concern about the lack of students electing science teaching careers was the reason that the Office of Educational Research and Improvement of the U. S. Department of Education, the National Council of Teachers of Mathematics and the Wisconsin Center for Education Research convened a conference to outline steps and suggest actions to improve school mathematics teachers' education. Upon implementation of the suggested actions changes are expected to occur the following areas:

1. content and structure of courses
2. course requirements
3. sequencing and segmenting of mathematical topics;
4. use of technology
5. methods of assessment;
6. knowledge and professional responsibility of teachers;
7. way mathematics is taught;
8. policy environment within communities; (Romberg, 1985).

Admitting that it is difficult to draw conclusions

about the effectiveness of programs initiated to increase the number of persons certified to teach science (Klein, 1982; Shymansky & Aldridge, 1982), many organizations and states have initiated efforts to address the perceived shortages. These initiatives include a program to certify science teachers who meet or exceed the standards set by the National Science Teachers Association at various education levels and in different science subject fields. The standards include 12 credit hours of science for every elementary teacher; 36 credit hours for every junior high science teacher and 50 credit hours for every high school science teacher (NSTA, 1985).

Although warned that certification programs for teachers who have never studied in teacher education programs could jeopardize the future of the programs and lower the quality of the teaching profession, the State of New Jersey adopted such a program to certify science and mathematics teachers (Manpower Comments, 1985).

The 1983 report of the National Science Board Commission on Precollege Education in Mathematics concluded that top priority must be placed on retraining new teachers and training them well so that all will be of high quality.

Many opinions have been voiced about how to reform the school system so that it is more responsive to the problems that exist in science and technology. Those who believe that the educational system should be reformed agree somewhat on steps to correct the situation: all students

should take more mathematics and science courses (Rowe, 1984) - at least three years of each in high school (NSF, 1983); more versatile educational materials should be created; educators should increase their knowledge of the subjects they teach; more women, blacks and Hispanics should be entering mathematics and science (Berryman, 1983; Malcom, 1983; Vetter, 1984).

Minorities and Females

With the college-age population not only declining, but the make-up of that cadre changing dramatically from primarily composed of whites to one composed more and more of Hispanic and blacks...(Hodgkinson, 1987).

Because of the demographic trends there are efforts to increase the rate of participation of women and minorities in science and engineering careers. The decision to go into science and engineering "is made by neglect" (Andelin, 1986). Neither girls nor minorities - together the largest segment of the whole population - take these courses in anything like representative numbers. But gender-stereotyped career expectations and differential treatment of women and minority scientists in the work force are two factors discouraging members of these groups from entering the fields. (OTA, 1985).

The underrepresentation of minorities in U.S. science and engineering is receiving renewed political attention in Washington (Walsh, 1987). Demographics changes

have an impact on these developments as well (Vetter, 1987). Efforts are being made to cope with this changing situation. Minority Research Centers of Excellence have been established to "develop untapped U.S. talent" (NSF, 1987). Minority Institutes in Science, Space and Technology (MISST) have been established to "increase the awareness of science, engineering and technology in the minority community." (U.S. House, 1987), and special efforts to recruit women and minorities into technical fields have been initiated (Manpower Comments, 1987).

According to the National Science Foundation (1987) programs aimed at bringing more women and minorities into the sciences would cost less than ones that would make all students in the sciences eligible for special support (NSF 1987).

Intervention Programs

Educational programs that address a problem that is not being adequately addressed by the educational system are classified as intervention programs. Most of the mathematics and science intervention programs have had as their goal the increased participation of females and minorities in science and math related careers. Their ability to attract federal and foundation funding was enhanced after national attention was focused on them (Malcom, Aldrich, Hall, Boulevard, & Stern, 1984).

Intervention approaches to increase the participation of minorities and females in math and science careers have been shaped by what is known regarding barriers that exist for these groups (Clewell, 1986). Some of the factors linked to success of the intervention programs are: the presence of role models to motivate students' interest (Malcom, 1984); hands-on experiences (Malcom, 1984; National Science Board, 1983) that place heavy emphasis on the applications of science and mathematics and on careers in these fields (Fisher, 1984), and commitment of students. Interventions create more time-on-task for students, leading to increased productivity (NIE, 1985; NSB, 1983).

Most of the first math and science intervention programs were aimed at undergraduate and high school students, but awareness that exclusion from the pipeline occurs before high school (Berryman, 1983) has resulted in efforts directed at middle school students.

Results that emerged from large cross-national studies of elementary school children suggest that the focus should not be solely on improving the performance of high school students. The problems arise earlier as indicated by the comparisons of Japanese, Chinese and American children.

American kindergarten children lag behind Japanese children in their understanding of mathematics; by fifth grade they are surpassed by both Japanese and Chinese children...Cognitive abilities of children in the three countries are similar, but large differences exist in the children's life in school,

the attitudes and beliefs of their mothers, and the involvement of both parents and children in school-work (Stevenson, Lee and Stigler, 1986).

Studies show that the pipeline begins in seventh and eight grades, when students are first able to elect mathematics and sciences courses (Pine, 1987). A finished scientist or an engineer takes a fixed amount of time to manufacture, the process cannot be speeded up. "By the time the supply system works, the problem either is out of hand or has gone away," according to Naismith (1987). Analysts agree that the number of those who go into science and engineering will depend on the beginning of the pipeline, that is, on the number of schoolchildren deciding to take courses based on quantitative thinking (Finkbinder, 1987).

In letters to the chairmen of the House and Senate Appropriations subcommittees with jurisdiction over NSF Erich Bloch, outlined a new NSF program to strengthen the interest and skills of elementary and junior high school students in mathematics and science (1985). And as a first step NSF awarded \$6.6 million in grants to three private research centers to work with text book publishers and selected schools to develop new teaching materials for children in kindergarden through sixth grade (NSF, 1987).

Professionals Scientists as Educators

Ongoing debate about science content and the role of

the professional scientists as educator continues to be found in the literature. Some reports say that school science is too dull, too abstract and too far removed from the interest of the average teenager. Rowe (1984) argues that science has been turned into something resembling a foreign language, with students memorizing term after term without much understanding. "Scientists could facilitate the understanding of the concepts by presenting information about current research and its applications."

Supporting the role of scientists in the classroom, and setting the scene for productive relationships between students and research and development personnel, Gray (1987) expressed the view that professional educators stifle the scientific development of even the most gifted children "with traditional staffing and narrow-minded politics." To support his position that students taught by professional scientists would result in more technically competent young people, Gray states:

A scientist views science with awe and wonder, mingled with an insatiable curiosity about the architecture of the atom, the order of the universe, the miracle of life. It is unlikely that the average teacher is able to inspire the spirit of wonder and dedication so necessary to a creative scientist (1987).

Scientists became involved in the reformation of the science curriculum in the 40's and 50's (Kriehbaum and Rawson, 1969). Sputnik I in 1957 renewed the crisis in science curriculum and many scientists were eager to re-

shape the rationale for science education that evolved in the 1930's and 1940's but were not given the opportunity to do so at that time (Blanshard, 1959). The scientists assumed that "if students understood science the way scientists know science it would be inherently interesting" (ACS, 1984; Hurd, 1986). "If scientists could help win a war, they should be able to solve the problem of outdated and dull science textbooks" (Duschl, 1987).

Numerous curriculum development projects were funded by the National Science Foundation (NSF) but the "new" science courses developed by the professional scientists were rejected in the classroom because they too difficult for most students, and the concepts and inquiry methods were not understood by teachers (Hurd, 1986).

Recent concerns by scientists about whether new developments in science and technology are being covered sufficiently in the current curriculum, served as the catalyst for initiating Project 2061. (Manpower Comments, 1987). The project, a collaborative effort among scientists, engineers, historians, and philosophers is charged with the development of an intellectual framework necessary for a fundamental and continuing restructuring of science and technology education in the nation's schools. (AAAS, 1987).

Federal Involvement

Building the case for federal involvement in increasing the supply of scientists and engineers Wilson Talley, 1983, promoted the idea of using "Centers of expertise." The centers of expertise, the academic equivalent of the "warm production line" would be maintained to assure a stream of products - talent in a vital area.

The Department of Defense (DOD), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA) have scientists and engineers who are local or national experts in their areas of technical competence, in addition the laboratories of such agencies have research equipment unavailable to local colleges and universities (Talley, 1983).

Talley suggested that provisions should be made to use these personnel as formal instructors and research advisors, and to consider the facilities as research tools to increase the science and engineering pool. To support his position, Talley points out the following :

- 1) Science and mathematics education in primary and secondary schools is too important to be left to professional educators who are technologically illiterate.
- 2) The geographical dispersion of Government laboratories and installations offers opportunities for Government scientists and engineers to alleviate the national problem of technological literacy in elementary and secondary mathematics and science.
- 3) Release time for scientists and engineers to teach in public schools, loans of equipment and laboratory facilities to schools, and enrichment programs for teachers and students to provide

scientific updates for teachers could be initiated (1983).

The Department of Energy has an on-going extensive and varied relationship with the nation's colleges and universities. As a Federal R & D mission agency, the Department has an important complementary responsibility to help ensure that an adequate supply of highly qualified well trained scientific and technical professional is available to meet current and future research and development needs. This responsibility is met through the involvement of students in its research projects and through the use of Departmental facilities and equipment in the education and professional development of students (DOE, 1986).

Annually, an average of 350 postdoctoral researchers conduct full-time research at the major DOE laboratories, and are supported by DOE, in addition to 3000-3500 graduate students each year on university research projects, and 1200 undergraduate science engineering students each summer in both research and instructional programs at 30 DOE facilities (DOE, 1986)

Due to release of reports outlining the "crisis" in science and mathematics education and priority given by President Reagan to strengthening and improving precollege education, DOE has provided increased support for secondary school science teachers and students, and strongly encourages its facilities to take an active role in the education

of elementary teachers and students in scientific literacy (DOE, 1986)

The results of this literature search indicates that the "crisis" in precollege science and mathematics education is multifaceted. The responsibility for the situation is widespread. Reform for the educational system will take time and widespread, energetic, dedicated action from all segments of our society. Improved preparation of all students in the fields of mathematics, science, and technology is essential to the maintenance and development of our nation's economic strength, to its military security, and to fulfilling personal lives for its people. Thus, there is a need to survey the Department of Energy community in a consistent fashion to determine the extent to which the Department is fulfilling its responsibility for developing scientific personnel.



CHAPTER III.

METHODOLOGY AND PROCEDURES

This study focused on describing the existing condition of precollege science education programs at DOE facilities. The methods and procedures used in this study were selected because they were deemed the most appropriate techniques for answering the questions in the research. The methods and procedures used are described by Issac and Michael (1971) as "descriptive research."

Research Questions

This investigation was guided by the following research questions:

- 1) What policies or mandates served as the catalyst for initiating precollege science education at the DOE facilities?
- 2) Which DOE facilities sponsor precollege science education programs?
- 3) What is the programmatic scope of the DOE precollege science programs.?
- 4) Who provides the financial support for the DOE precollege science programs and how are these funds used?

5) To what extent do the DOE facilities agree on the appropriateness of the guidelines developed during the 1984 DOE Precollege Conference?

Procedures

The study was carried out in two phases. In the first phase, a questionnaire (final form is in Appendix B) was mailed to the director of each appropriate Department of Energy facility along with a stamped return envelope and a personalized letter of transmittal. A mailed questionnaire was used in this study because it was inexpensive and it could be designed in a simple clear manner. Little concern was given for the typical low response rate of mail questionnaires since there were prior assurances that the population being surveyed would respond. The instrument was pilot tested on five Department of Energy facilities during the Summer of 1986. These facilities offered precollege activities during the 1986 fiscal year. The precollege personnel at these five facilities were given the opportunity to discuss the quality and relevance of the questions in the survey and to comment on perceived ambiguity and/or redundancy in the instrument. Additional evaluation of the instrument was sought from Argonne National Laboratory's Division of Educational Program staff. Following this phase of the study, the survey instrument was revised.

Site visitations and individual interviews of Pre-college personnel at the six facilities selected from

different geographical regions were used to complete the second phase of the project. The interviews were conducted as a method to further validate the survey and to explore significant areas not indentified in the original survey. An interview guide (Appendix C) was used during the second phase.

Population

The population for this study consisted of sixty-eight (68) different research and technical development contractor facilities that comprise the Department of Energy research and development operation. These facilities are located in almost all the states of the Union. (Figure 1)

Figure 1.

DOE Field Facilities and Operations Offices



The Department of Energy has categorized the facilities according to the type of mission assigned. The following are these categorizations:

1. Multiprogram Facilities - scientific and technical efforts are directed toward several missions. These facilities conduct programs which range from the most fundamental research in the physical and life sciences to the most advanced goal-oriented design and development plans in nuclear and alternative energy technologies and nuclear weapons.

2. Program-Dedicated Facilities - scientific and technical efforts are directed toward one single mission. The research conducted by the facilities focus on single issues, i.e., biomedical, safeguards and security, fossil energy, fusion, nuclear development, physical research, and solar energy.

3. Enrichment, Production, Testing and Fabrication Facilities - These facilities are involved in a wide spectrum of nuclear activities from research on exotic elements to the production of nuclear materials for weapons components to medical/- industrial uses (DOE, 1986).

The sample for the first phase of the study consisted of forty-eight (48) facilities that employed at least twenty persons with advanced degrees (Ph.D, M.S.). These facilities are listed in Appendix A. Twenty professional staff was considered to be the minimal number necessary to facilitate precollege activities at any one site. Telephone follow-up calls were made as needed. A subsample for the second phase of the study consisted of six facilities from different geographical regions. Included in this sample were:

Argonne National Laboratory, Argonne, Illinois

Brookhaven National Laboratory, Upton, New York

Lawrence Berkeley Laboratory, Berkeley, California

Los Alamos National Laboratory, Los Alamos, New
Mexico

Oak Ridge National Laboratory, Oak Ridge, Tennessee

Pacific Northwest Laboratory, Richland, Washington

Site visitations to each of the six facilities coupled with interviews with the precollege personnel were used to complete the second phase of the project. Although this portion of the data collection was expensive, time-consuming, and inconvenient, it allowed for deeper probing and therefore resulted in a better understanding of the questionnaire data collected.

Limitations

With the use of a survey and interview as methods of collecting data, there existed a possibility that the respondents would interpret the same questions in different ways. Also inherent in this procedure was the fact that the recording and interpretation of the data involved subjective interpretation by the interviewer.

Another limitation of this study was the willingness of the respondents to reveal the level and source of the funds used for precollege education programs. To control for this factor, the respondents were asked to "estimate" the level of funds allocated for precollege activities.

Analysis of Data

Upon receipt of the questionnaires the responses were tabulated and analyzed. A narrative analysis was augmented with charts and graphs that described trends, patterns, differences, uniqueness and possible explanations for the data.

CHAPTER IV

PRESENTATION OF DATA

Introduction

A survey of the forty-eight Department of Energy field facilities located in various geographical locations throughout the country was conducted in August, 1987. All forty-eight of the facilities who were asked to participate in the study completed and returned the questionnaire. In addition, on site visits and interviews were conducted at six selected facilities.

The following format is used in presenting the findings of this study. A summary of those activities which precipitated "formal" precollege science education programs at DOE facilities is presented first. A reporting of the survey results follows. The findings for each item are then presented in the following manner: total DOE facilities results, Multiprogram Facilities results, Program-Dedicated Facilities results, and finally, Enrichment, Production, Testing, and Fabrication Facilities results. Following this, a summary of each item is presented. After all results of the survey are presented, a report of the interviews conducted with six DOE facilities are presented with appropriate summaries.

An integrated "whole" is provided in the "summary" section of the report.

Catalyst for Precollege Recognition

Research Question Number One was - What policies or mandates served as the catalyst for initiating precollege science activities at DOE facilities?

In an effort to understand what actions or mechanisms served as catalysts for formal recognition of precollege activities at the Department of Energy's Facilities, the investigator searched the records of Argonne National Laboratory and its operations office, (The Chicago Operations Office [CH]) which resulted in the discovery that a press release from the Office of the White House Press Secretary (1979) initiated formal pre-college programs the Department of Energy Facilities. Through this Release, President Carter announced a program of

"Apprenticeships for minority high school students beginning in the summer of 1980. The program is designed to strengthen the nation's and the government's effort to recruit and sustain minority students in science and engineering."

Seven federal departments and agencies including the Department of Energy, the Department of Defense, the National Aeronautic and Space Administration, the Department of Agriculture, the National Science Foundation, and the Environmental Protection Agency, sponsored programs involved students during the summer of 1980.

In response to DOE's encouragement to be involved, DOE facilities submitted proposals and requested funds to participate in the program.

The report of the National Commission on Excellence in Education, issued in 1983, highlighted the decline in the quality of precollege education. Thus, precollege science and mathematics education became an issue in the 1984 elections. The debate was concerned with the degree to which the federal government should be involved in the funding of programs to raise the educational level of American students and their teachers to that of the other industrialized countries. At stake was a perceived acceleration in the decline of U.S. competitiveness in science and technology, thus a weakening of the economic and military security (C & EN, 1983).

In October, 1983, after passage of S. 1285, the Education for Economic Security Act, President Reagan initiated a National Partnership in Education Program.

This Program is directed at helping local elementary and secondary schools strengthen their educational programs through forming partnerships with local industry, universities and colleges, and Federal agencies (White House, 1983)

Donald Hodel, the Secretary of Energy, at that time, sent a memo to President Reagan which stated in part:

...Your new initiative, "Partnerships in Education," is an excellent way of making Government more responsive to local education needs. Our Agency

(DOE) across the country will be identifying schools and establishing the partnerships you describe in the near future...I want you to know that the Department of Energy (DOE) and its predecessor agencies have principally focused on strengthening our Nation's scientific and technological base through support of research at the graduate level but also have included commitments to undergraduate education. Today, we recognize the real problems facing our educational system, particularly in science and mathematics. Consistent with the spirit of your recent initiatives in this area... I will encourage our facilities to use their imagination in responding to your proclamation and doing even more with local schools in the future. (DOE, 1983).

Although some precollege education activities had already been conducted by a number of Department of Energy's facilities, this memorandum served as the official recognition of precollege programs. Subsequent memoranda have been issued by the current Secretary of Energy, John S. Herrington, reminding the DOE facilities of their responsibility for educating precollege students. The following statements are indicative of this support:

...with the increasing importance of education and science to the future of the Nation, I want to ensure that the Department is doing all that it should to develop fully the Nation's scientific talent at the precollege level in order to meet the Nation's future scientific and technological needs (DOE, 1987).

...I want to call your attention to National Science and Technology Week... Special activities involving your local school partners should be scheduled during this week as part of this national celebration of American Science and Technology (DOE, 1987).

The Director of the Office of Energy Research is responsible for the Department's overall participation in the President's Partnerships in Education Program. Please keep him informed of your efforts and those reporting to you (DOE, 1987).

Facilities Offering Precollege Activities

Research Question Number Two was: Which DOE facilities sponsor precollege science education programs?

The results of this survey show that thirty-two of the forty-eight (67%) surveyed facilities reported offering at least one precollege activity. Included in this group were facilities in each of previously stated DOE mission categories. Some of the reasons given by personnel from the 16 facilities that reported no precollege activities were:

"No formal precollege activity...All contact with high schools done strictly on private basis."

"Mission does not provide a basis to support pre-college activities..."

"Resources, staff and funds, do not allow for participation in this type of program."

"We operate within a restricted environment, special clearance is needed."

Table 1 presents the number of facilities surveyed, by DOE Mission Category, the number reporting precollege activities and the percent of each categorical facility offering precollege activities.

Nine or 100 percent of the Multiprogram Facilities offer some type of precollege science activity. Fifty-two

percent, or 15 of the 29 Program-Dedicated Facilities surveyed reported sponsoring precollege activities, and 8 or 80 percent of the Enrichment, Production, Testing and Fabrication Facilities conduct precollege activities.

TABLE I

Number and Percent of DOE Facilities that Offer Precollege Activities

Category	Number Surveyed	Number With Activities	Percent With Activities
Multiprogram	9	9	100
Program-Dedicated	17	15	52
Enrichment, Production, Testing, Fabrication	10	8	80

Contrary to what might be expected, a large percentage of the Enrichment, Production, Testing and Fabrication Facilities respondents report sponsoring precollege activities. The mission of these facilities includes the production of nuclear materials for weapons components, weapons production and testing. The activities appear inappropriate for precollege program use. The individual scientists, however, express an interest in precollege science education.

Twenty-seven different precollege activities is the largest number reported by a single Department of Energy

facility. The smallest number offered is one. The number of precollege activities offered at the Multiprogram Facilities is presented in Figure 2. Figures 3 and 4 present this information for Program-Dedicated Facilities and Enrichment, Production, Testing and Fabrication Facilities, respectively.

Note that the largest number of activities, twenty-seven (27), are offered by the Multiprogram Facilities as compared to fifteen (15) offered at the Program-Dedicated Facilities, and seven (7) at the Enrichment, Production, Testing, and Fabrication Facilities.

Figure 2.

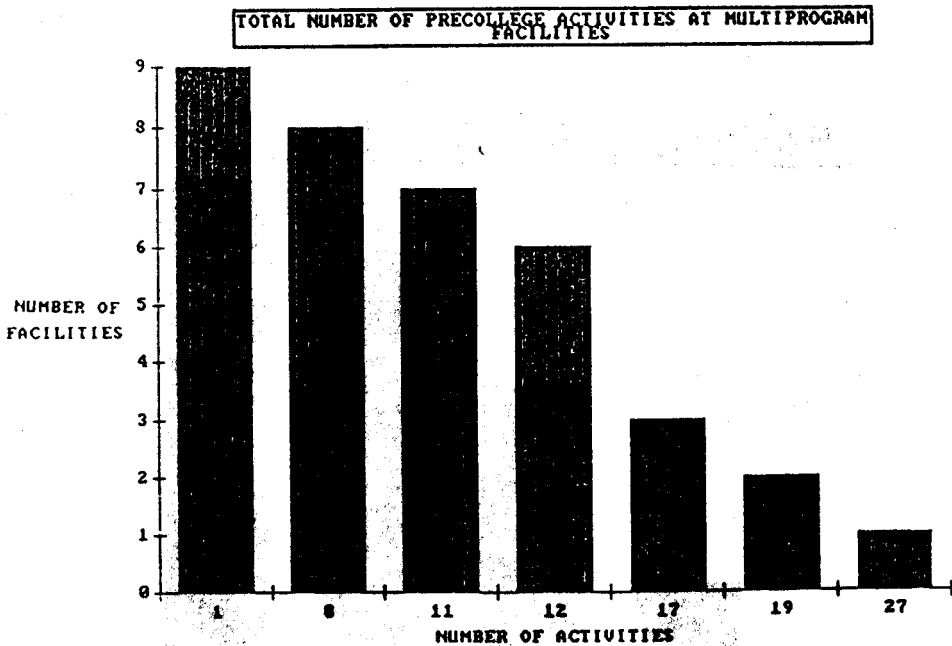


Figure 3.

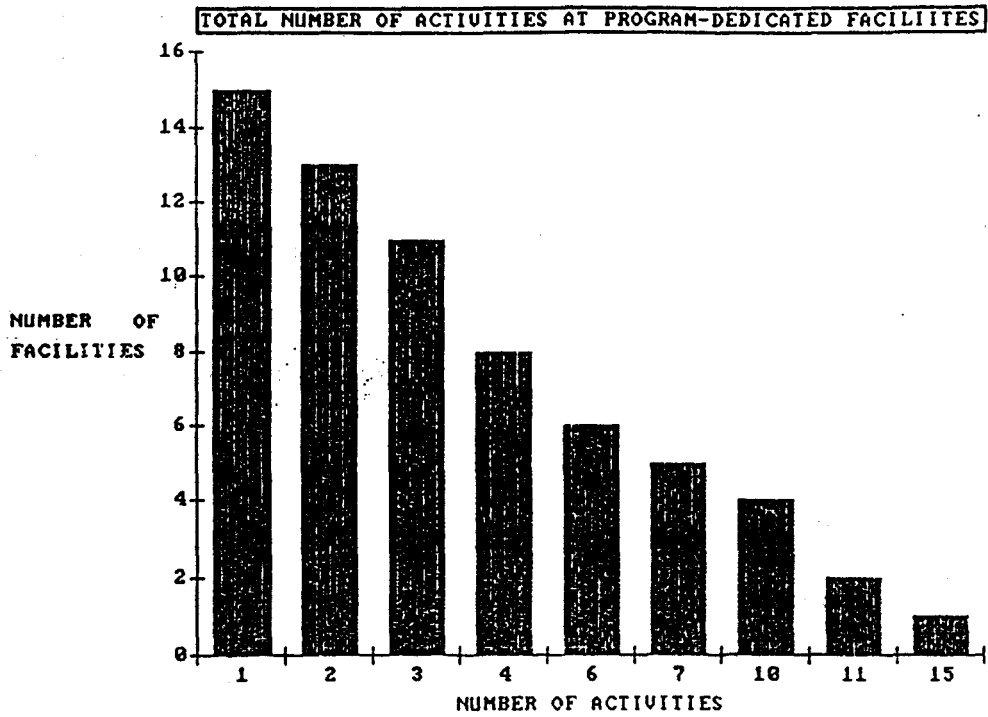
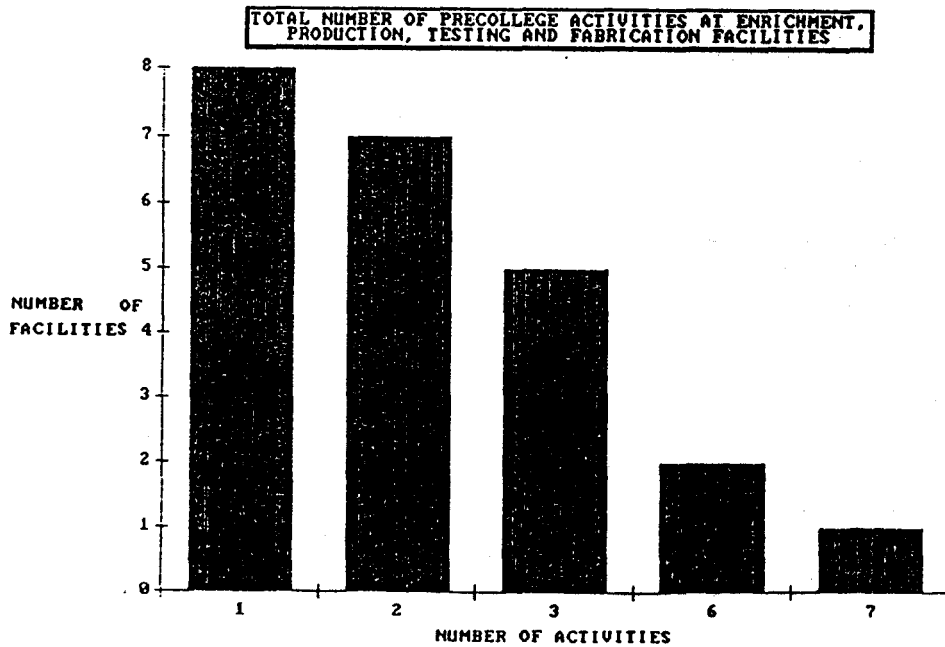


Figure 4.



Scope of Precollege Activities

Research Question Number Three was: What is the scope of the precollege science programs sponsored by the DOE Facilities?

In reviewing the data collected from the surveys it was determined that the type of precollege activities offered at the DOE facilities could be placed into eight (8) basic categories. These categories are:

1. Research Participation-

Precollege activities that are integrated into actual, ongoing research in the laboratory. The participant may or may not get paid. College credit may or may not be awarded.

2. Workshops and Institutes-

Precollege activities that are conducted as structured group experiences with focused institutional goals. The methodology may include lectures, discussions, and "hands-on" activities. The term of the activity can vary from one day to several weeks.

3. Curriculum Development/Instructional Materials

Classroom materials that are developed as the result of specific curriculum development programs or as spin-off from other precollege activities.

4. In House Tours, Lectures, Demonstrations-

Activities that are generally conducted by the Public Affairs Office and not an integral part of another precollege program.

5. Classroom Direct Instruction, Lectures,

Demonstrations-

Formal programs are conducted where scientists/engineer present or demonstrates scientific concepts to entire class of students or precollege teachers. The professional researcher is responsible for the scope and sequence of the curriculum being presented.

6. Community/Professional Outreach-

participation by the DOE facility in local and national professional educational organizations, on community partnership councils, and other committees whose focus is precollege science education.

7. Special Events-

Competitions are coordinated or sponsored, such as science bowls, annual science fairs, National Science and Technology Week activities, Edison Day, conferences, seminars and institutes.

8. Ad Hoc Support Activities-

Informal responses are made to requests from

individuals outside of DOE facilities for loans of equipment and personnel.

Most Frequently Occurring Precollege Activities

The activities most frequently reported by all DOE Facilities are presented in Table 2. Activities that can be delivered to large audiences with a minimum amount of perturbations appear to be the most frequently conducted. These activities include lectures, tours, and demonstrations. These same activities are also the ones most frequently reported by Multiprogram (Table 3) and Program-Dedicated (Table 4) Facilities.

Lectures, demonstrations, and external involvement with school districts are the activities most frequently reported by the Enrichment, Production, Testing and Fabrication Facilities. (Table 5) The type of research conducted at these facilities might preclude the offering of activities that bring students and teachers on site.

TABLE II

Most Frequent Precollege Activities as
Reported by DOE Facilities

Activity	Frequency N=32
External Lectures	24
Tours	23
Internal Lectures	20
Demonstrations	17
Student Research Participation	14
Summer Jobs for Teachers	11
Workshops	11
Teacher Research Participation	6
Curriculum Development	8
Teacher Institutes	7
Summer Programs for High School Students	6
Explorer Scouts	6
Student Institutes	5
Saturday Programs	5
Adopt-a-School	4
Science Fair Judges	4

TABLE III
Most Frequently Occurring Precollege Activities
Reported by Multiprogram Facilities

Activity	Frequency N=9
External Lectures	8
Internal Lectures	8
Demonstrations	8
Tours	8
Summer Jobs for Teachers	8
Teacher Institutes	7
Workshops	7
Summer Programs for High School Students	6
Curriculum Development	5
Student Institutes	5

TABLE IV
Most Frequently Occurring Precollege Activities
Reported by Program-Dedicated Facilities

Activity	Frequency N=15
Tours	12
External Lectures	10
Internal Lectures	10
Student Research Participation	10
Student Institutes	6
Demonstrations	5
Workshops	4
curriculum Development	3
Summer Jobs for Teachers	3
Saturday Programs	3

TABLE V
Most Frequently Occurring Precollege Activities
Reported by Enrichment, Production, Testing
and Fabrication Facilities

Activity	Frequency N=8
External Lectures	4
Demonstrations	4
Adopt-a-School	4
Science Fair Judges	4
Tours	3
Explorer Scout Program	2
Internal Lectures	2
Saturday Program	2

Participants Served

The following information pertains to the type of individuals who participate in the DOE precollege programs. The respondents indicated that elementary and secondary students and teachers participate in precollege activities. Figure 5 shows that elementary students constituted the largest number (31,918) of participants in the DOE programs. There were 19,407 secondary students, 878 elementary teachers and 2855 secondary teachers reported as participants in the precollege activities.

The greatest number of students, elementary (27,669) and secondary (14,134) were reported by the Multiprogram Facilities. (Figure 6). One Multiprogram's facility's "adopt-a-school" activities accounted for almost 50% of the elementary students reported. Los Alamos National Laboratory has adopted all the school in all the counties in northern New Mexico. All of these activities are conducted in the individual school districts, not at the DOE facility.

Figure 5.

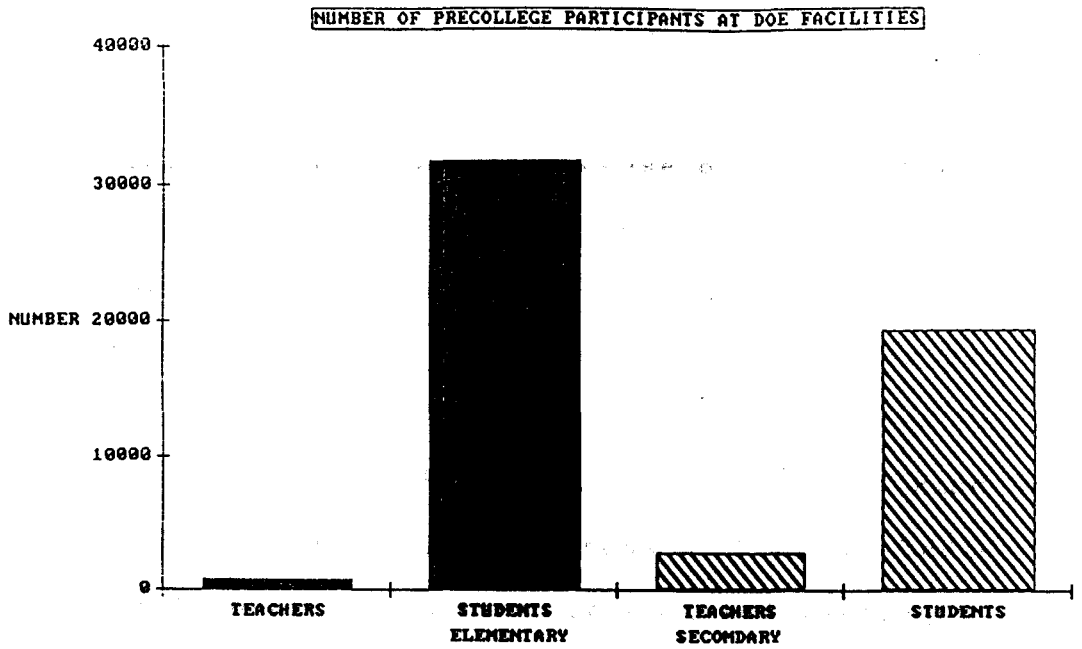
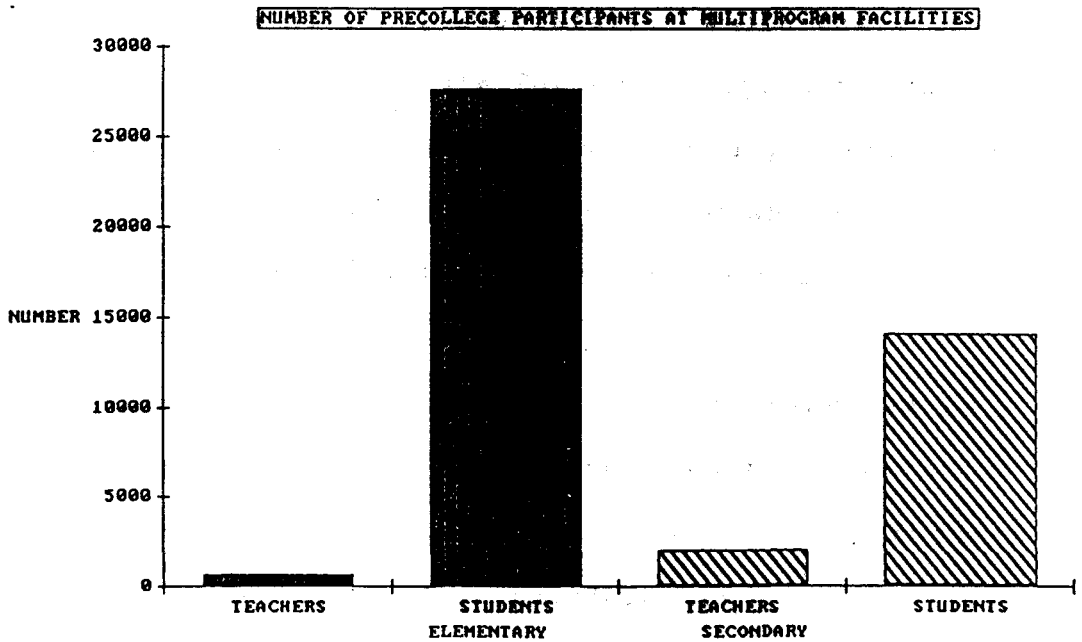


Figure 6.



Another large part of the reported elementary student participants can be attributed to facilities that have "Science Centers" (facilities that are designated for school children's use). These Centers are generally not located on the DOE facility site because of "classified" activities being conducted by the scientists. The centers provide a forum for the DOE facility to carry out precollege education activities in an area where precollege participants can come and go freely.

Figure 7 and Figure 8 present the number and kind of participants in the precollege programs at Program-Dedicated and Enrichment, Production, Testing and Fabrication Facilities, respectively. Most of the students, (elementary - 1774 and secondary - 4163) identified as participants at the Program-Dedicated Facilities were reported by one facility, Fermi National Laboratory. While there is limited space available on site for precollege activities, the Laboratory management considers precollege activities to be a priority item and operates in a collaborative manner with surrounding school districts in the implementation of these programs.

The elementary and secondary students reported in Figure 6 are generally served in activities that are connected with lectures and demonstrations. More students than teachers were reported as participants.

Figure 7.

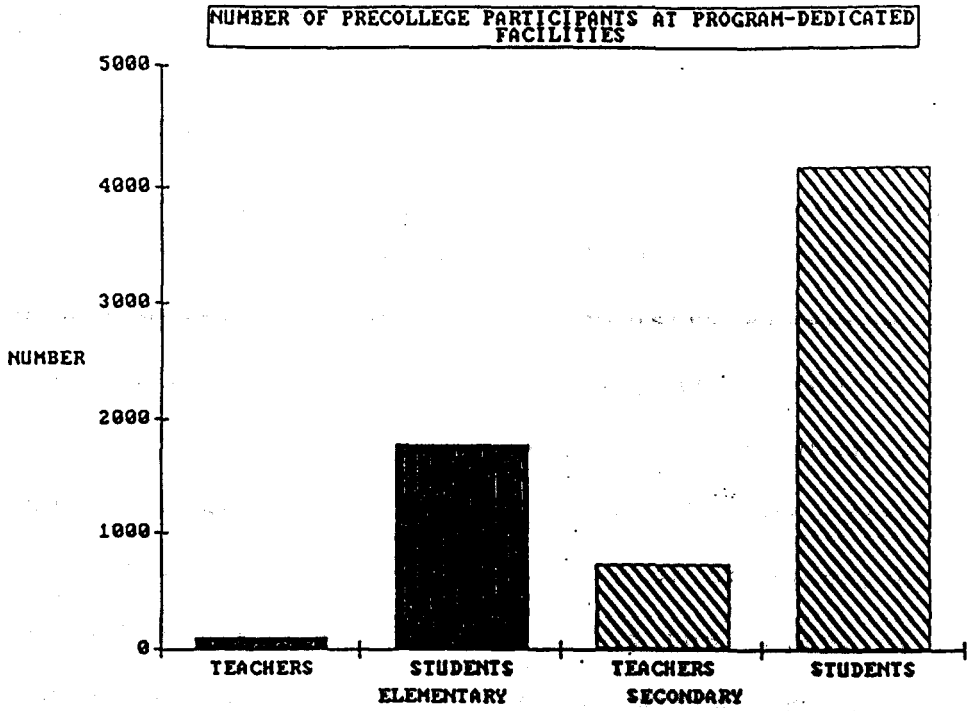
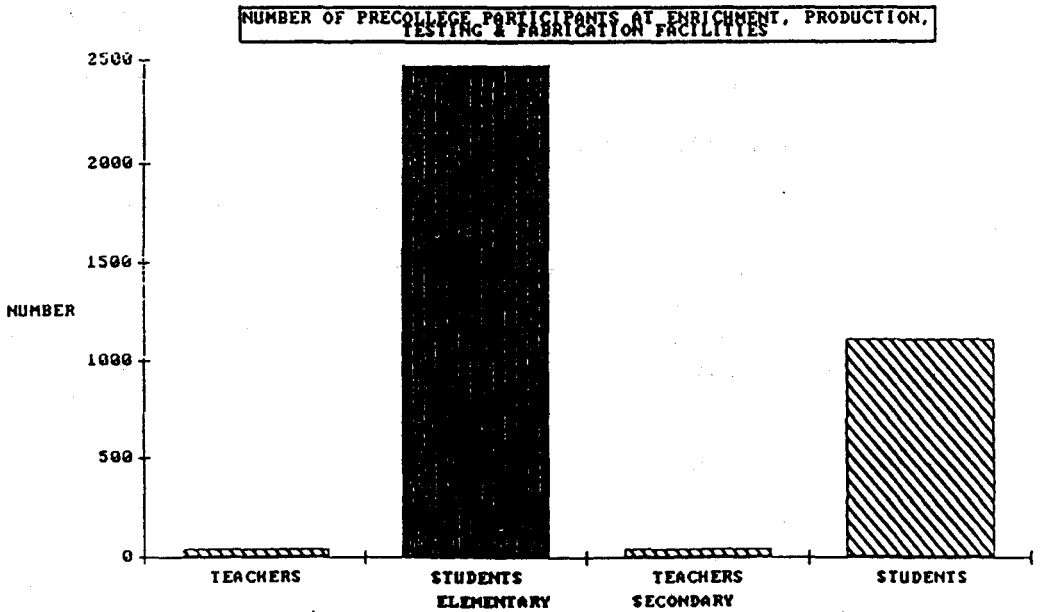


Figure 8.



Financial Support of DOE Precollege Activities

Research Question Number Four was: What are the sources of precollege support funds and how are they used?

When Discussing the stumbling blocks to successful precollege program implementation, Roundtable Working Group One, of the Government-University-Industry Research Roundtable, identified lack of financial support as one of the impediments: "Lack of dollars restricts the number, scope, and size of programs and those sources that do exist are not always reliable" (National Academy of Sciences, 1987).

An attempt was made to determine the extent of funds received by DOE facilities to support precollege activities. The respondents were asked to estimate the approximate amount of funds received for precollege programs, who provided them, and how they were used. Twenty-seven facilities responded.

Those who did not respond indicated the following: "we operate without a budget. The scientists participate in precollege programs on their own time."

"It is too difficult to estimate the amount of money used for these activities. If we revealed the actual amount and where it comes from the programmatic (scientific) personnel would be very upset."

The reported estimated amount ranged from \$500 to \$586,000.

Each respondent was also asked to estimate the

percent of funds received from standard funding sources.

These funding sources are:

1. The Department of Energy - funds received as the result of a proposal submitted to the Department of Energy specifically requesting funds to cover the cost of precollege activities.
2. Facility's operating budget - funds for precollege activities allocated from the total operating budget of the facility.
3. Director's discretionary funds - funds received from this account which are used for precollege activities.
4. Other sources - funds received from industry, and local and national foundations.

The largest percent of support for all DOE precollege activities is derived from the facility's operating budget. Figure 9 displays that 64.1% of the funds for programmatic support comes from the facility budget, 19.7% from DOE, 3.4% from the director's discretionary funds, and 12.9% from other sources.

The funds received for precollege activities are used for the following purposes:

1. Effort - Effort is the cost of persons hired to assist in precollege programs. This cost can be

in the form of salary to outside temporary employees or to the facility's scientific division staff to cover the cost of the time a scientist takes away from research to assist in a precollege activity.

2. Participant Support - Participant support is the amount of money paid by the DOE facility in the form of a stipend to the individuals who participate in precollege programs.
3. Materials and Services - Materials and services are the funds spent for equipment, supplies, printing, etc., needed to conduct precollege activities,

Figure 10 indicates that the largest percent of all DOE precollege funds are used for participant support - 39.5%, while 34.6 percent is used for effort and 25.9 percent is used for materials and services.

Figure 9.

SOURCE OF SUPPORT FOR DOE PRECOLLEGE ACTIVITIES

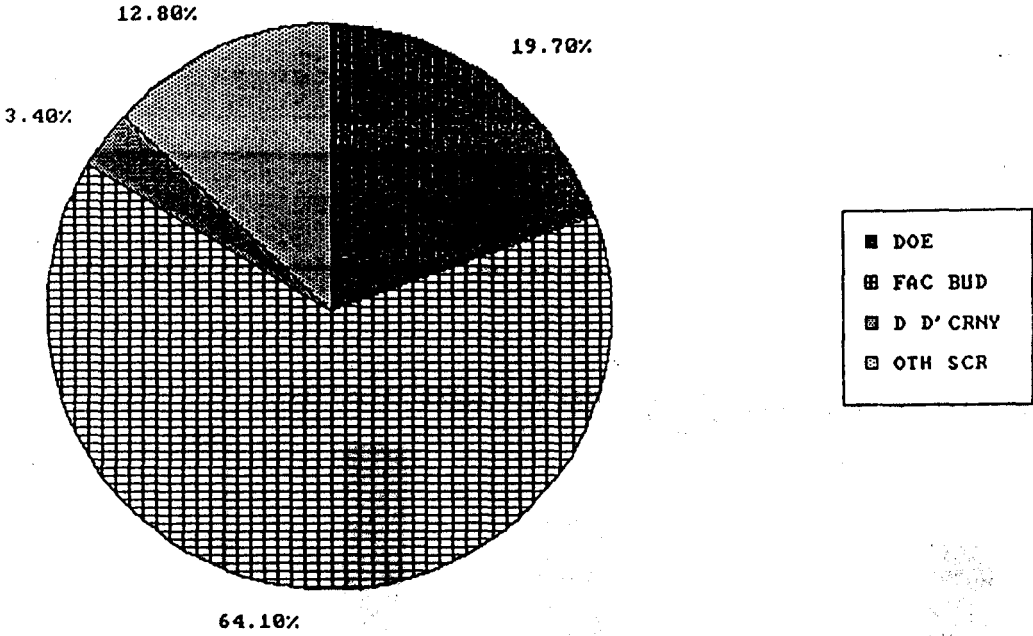
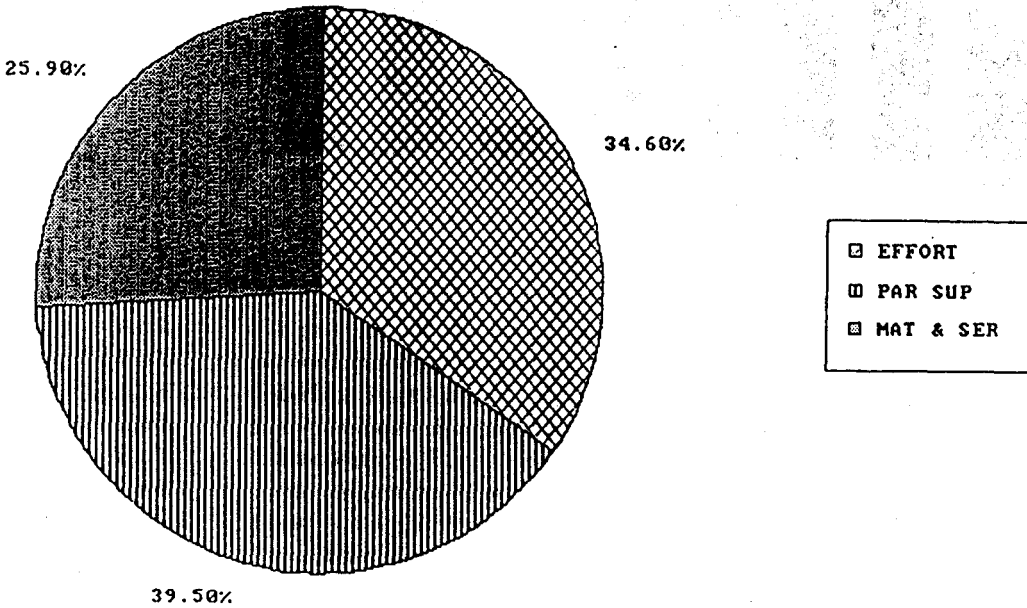


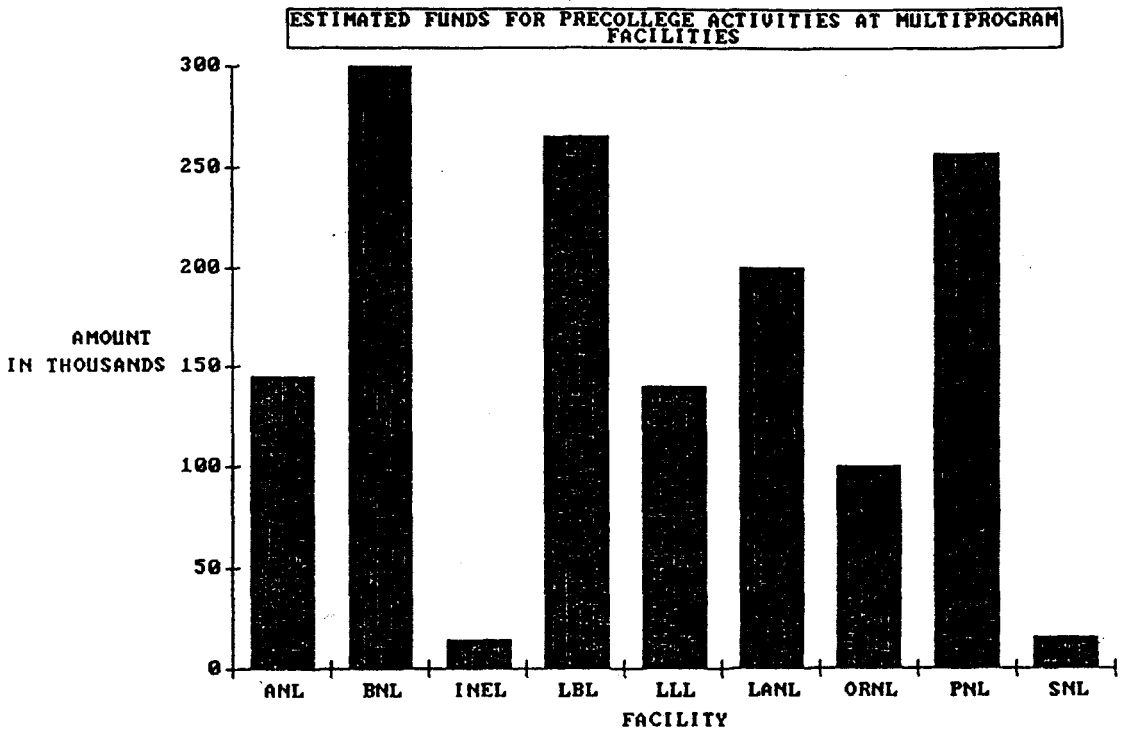
Figure 10.

USE OF FUNDS FOR DOE PRECOLLEGE PROGRAMS



The largest amount of funds received for precollege activities was reported by the nine Multiprogram Facilities (Figure 11). The maximum amount reported was \$300,000 and the minimum amount \$16,000.

Figure 11.



ANL	Argonne National Laboratory
BNL	Brookhaven National Laboratory
INEL	Idaho National Engineering Laboratory
LBL	Lawrence Berkeley Laboratory
LLL	Lawrence Livermore Laboratory
LANL	Los Alamos National Laboratory
ORNL	Oak Ridge National Laboratory
PNL	Pacific Northwest Laboratory
SNL	Sandia National Laboratory

The source of 66% of the precollege funds for the Multiprogram Facilities (Figure 12) comes from the facilities' operating budget, 27.4% from the Department of Energy, 4.1% from other sources, and 2.4% from the directors' discretionary funds. Figure 13 shows that almost 50% of the funds received by these facilities is used for effort, i.e., salaries and 20 percent used for supplies and services.

Figure 12.

SOURCE OF FUNDS MULTIPROGRAM FACILITIES

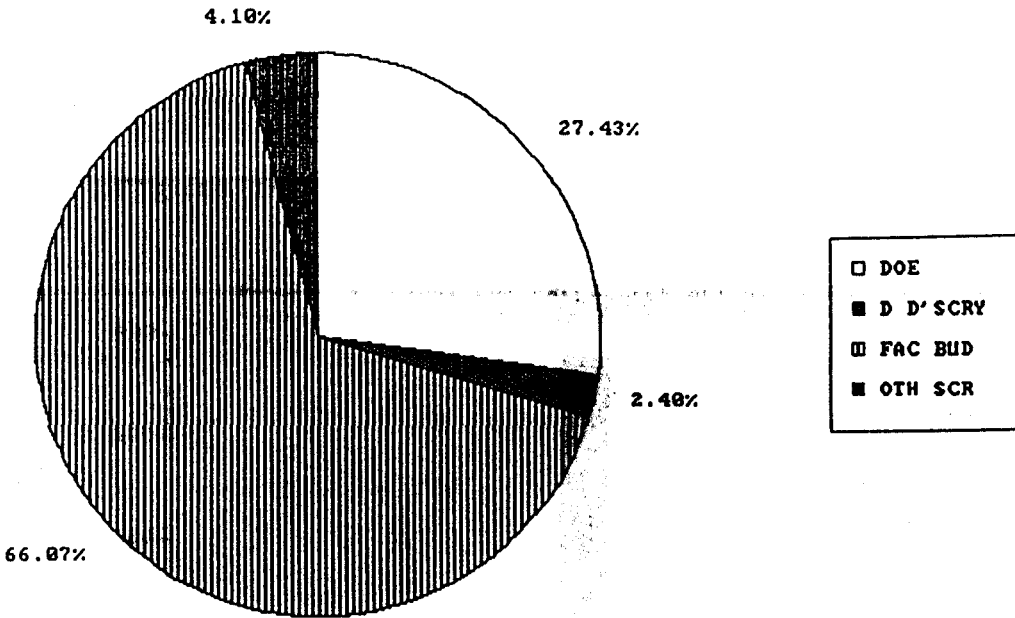
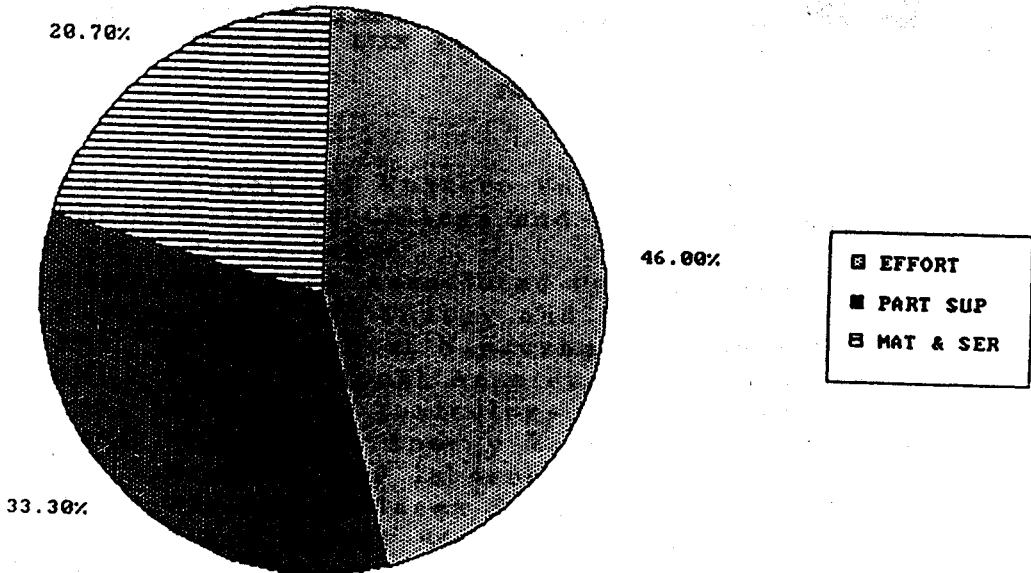


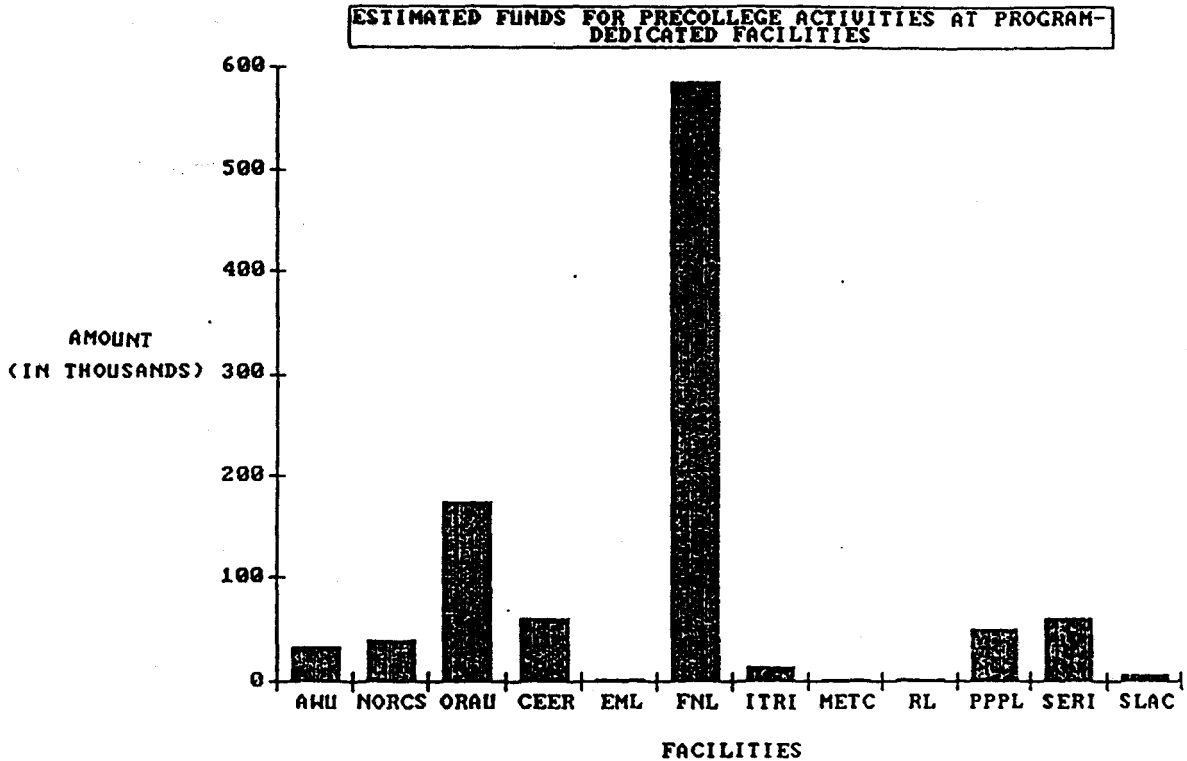
Figure 13.

USE OF FUNDS MULTIPROGRAM FACILITIES



The highest and lowest amount of funds received for DOE precollege activities were reported by the Program-Dedicated Facilities (Figure 14). The highest reported was \$586,000, the lowest amount \$500.

Figure 14.



AWU Associated Western Universities
 NORCS Northwest College and University Association
 for Science
 ORAU Oak Ridge Associated Universities
 CEER Center for Energy and Environment Research
 EML Environmental Measurements Laboratory
 FNL Fermi National Accelerator Laboratory
 ITRI Inhalation Toxicology Research Institute
 METC Morgantown Energy Technology Center
 RL Radiobiology laboratory
 PPPL Princeton Plasma Physic Laboratory
 SERI Solar Energy Research Institute
 SLAC Stanford Linear Accelerator Center

The Program-Dedicated Facilities reported the highest percent of funds received from other sources (Figure 15) and the highest percent of funds used for effort (Figure 16). When questioned about the reported 51% used for effort, the respondents reported that the Program-Dedicated Facility that received the largest amount of money for precollege activities (Fermi National Accelerator Laboratory), used a large portion of their funds to hire secondary teachers to conduct their precollege activities.

Figure 15.

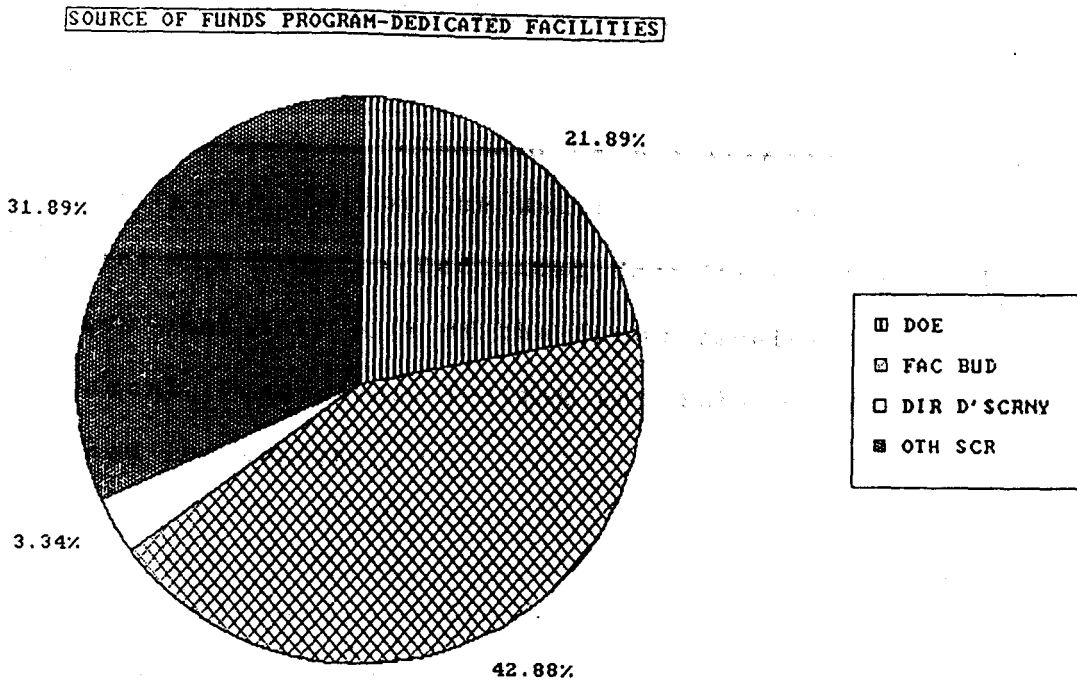
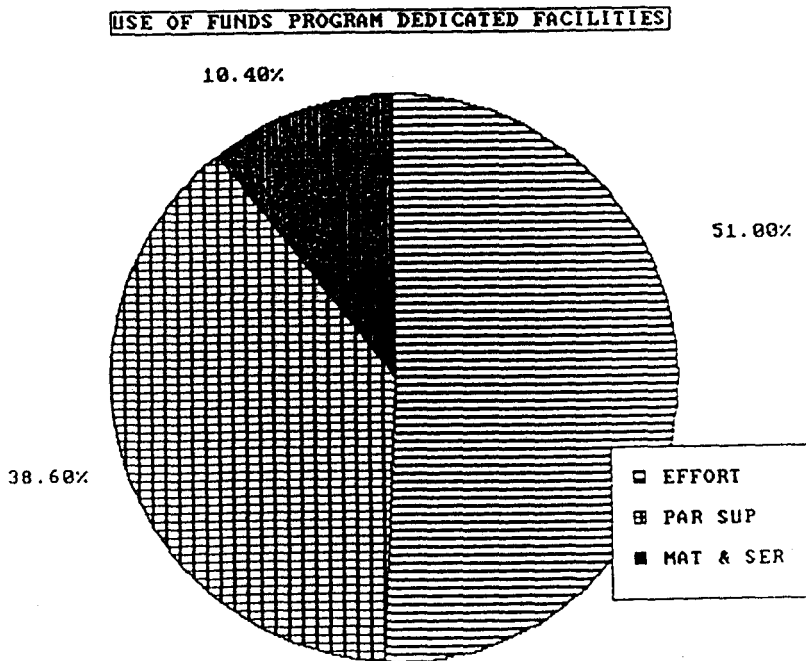
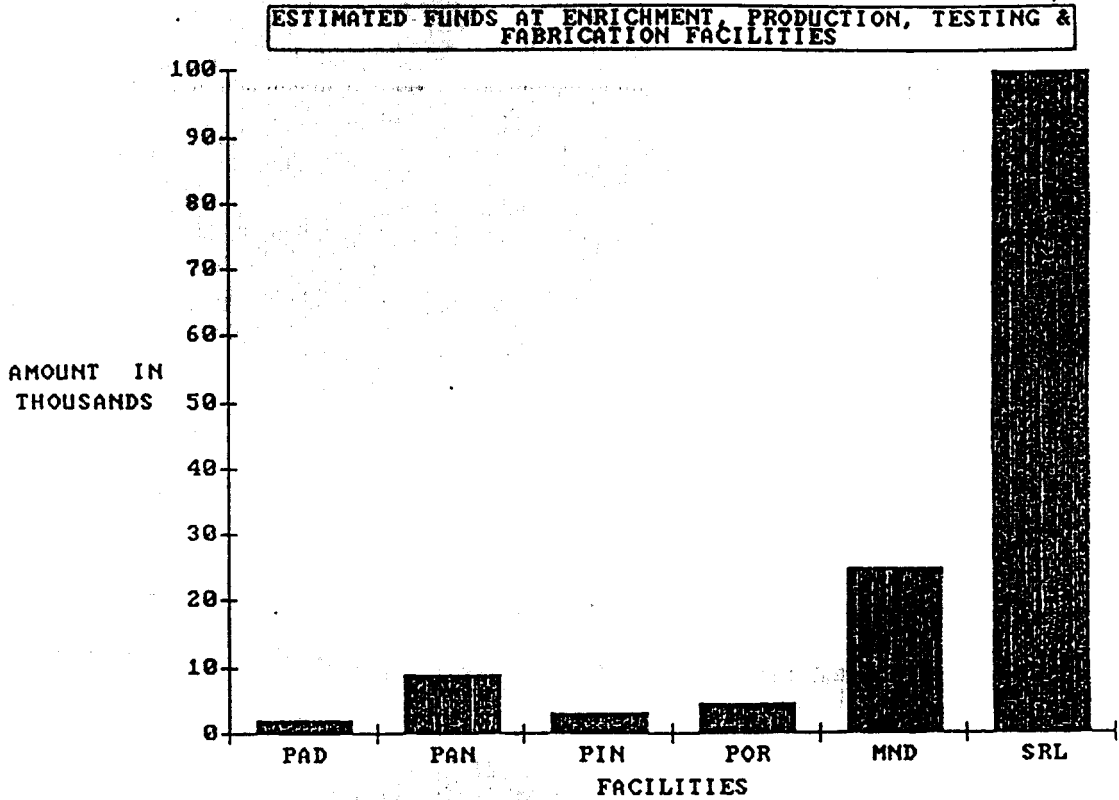


Figure 16.



The greatest amount of funds for precollege activities received by any Enrichment, Production, Testing and Fabrication Facility was \$100,000, (Figure 17). These facilities received the highest percentage of their funds from the facilities' operating budget (Figure 18), 83.3%, as compared to 56% for the Multiprogram Facilities and 42.8% for the Program-Dedicated Facilities. Figure 19 displays that only 6.7% of the funds received by the Enrichment, Production, Testing and Fabrication Facilities was used for effort.

Figure 17.



PAD Paducah Gaseous Diffusion Plant
 PAN Pantex Plant
 PIN Pinellas Plant
 POR Portsmouth Gaseous Diffusion Plant
 MND Mound Facility
 SRL Savannah River Laboratory

Figure 18.

SOURCE OF FUNDS ENRICHMENT, PRODUCTION, TESTING & FABRICATION FACILITIES

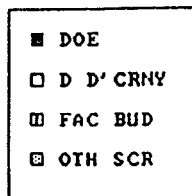
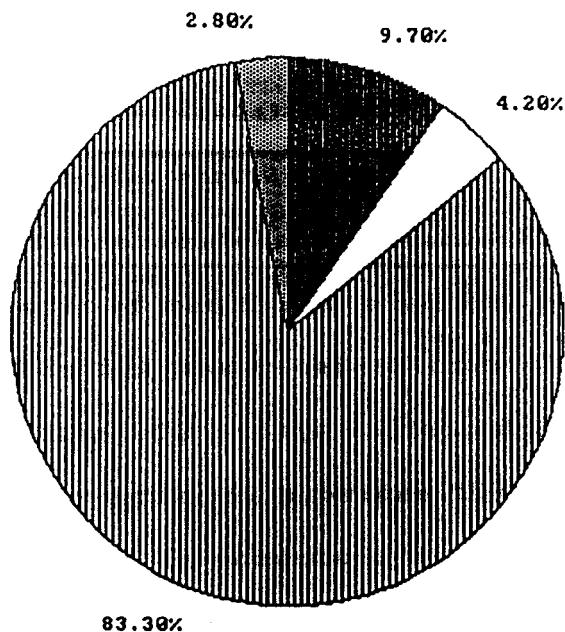
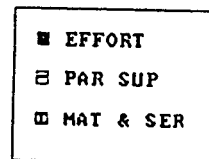
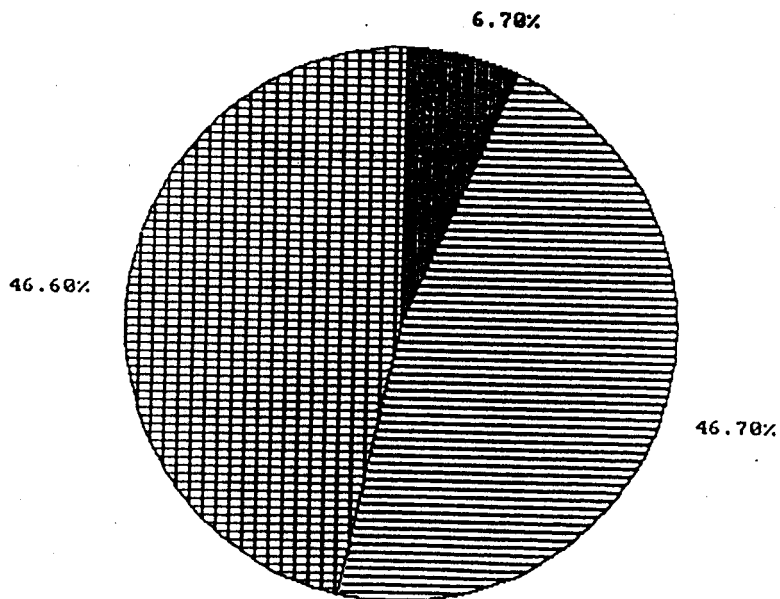


Figure 19.

USE OF FUNDS ENRICHMENT, PRODUCTION, TESTING & FABRICATION FACILITIES



With all the encouragement from DOE and the Administration to the DOE facilities to become involved in precollege science education programs, the data indicate that little financial support is received from DOE to implement the activities.

The respondents indicated that DOE provided 19% (Figure 9) of the funds used for precollege activities the other 80% was received from other sources.

While DOE provides limited funds for the total precollege program, it provides 100% funding for one specific program that is conducted at four DOE facilities. This program is the High School Science Student Honors Program.

The High School Science Students Honors Program was initiated in 1985 to recognize outstanding high school students and to help develop scientific and technical talent in energy-related areas. The program, two weeks in length, was host to two students from each state, the District of Columbia, and Puerto Rico.

In 1986, the Honors Program was expanded to include three additional facilities, bringing the number up to four, each serving as host to fifty-four students for two weeks.

The minimum cost to operate one of these programs is 100 thousand dollars. One of the facilities reported that it received one hundred forty thousand dollars from DOE to support the program each year since 1985.

Two additional facilities are to be included in the Honors Program in 1988, bringing the number of participating facilities up to six. The planned funding level from DOE for the program is as follows:

One facility will receive \$140,000;

Three facilities will receive \$100,000 each;

Two facilities will receive \$50,000 each;

The two facilities receiving \$50,000 each are expected to augment the cost of the Honors Program with funds from other sources.

In summary, although DOE has encouraged facility participation in precollege education activities, DOE's financial support has not been at a level to fully support all of the activities that are possible.

Guidelines For Precollege Activities

Research Question Number Five was; To what extent do the DOE facilities agree on the appropriateness of the guidelines developed during the 1984 DOE Precollege Conference?

Respondents in this study were asked to review the five guidelines that were developed during a 1984 DOE conference on precollege science education which focused on the role of DOE facilities in secondary education (ANL, 1985). There were 48 respondents who addressed the appropriateness or inappropriateness of the guidelines, including 12 who do not have precollege activities.

Conference Guideline Number One:

The Department of Energy Facilities should focus on programs that revitalize precollege teachers through having them spend internships with laboratory scientists during the summer. Institutes and inservice training should be conducted throughout the academic year.

Appropriate	Inappropriate	No Response
50%	19%	31%

While half of the respondents indicated that this guideline is appropriate for the development of precollege activities at DOE Facilities some reservations were expressed:

we agree on the desirability of such programs, however, the demands on laboratory workers to meet goals agreed upon with DOE are such that no time is available for extracurricular endeavours.

The only way we can accomodate teachers is by integrating them into ongoing research programs. It seems unlikely that the teachers would function at the same level as the post-doctoral fellows they would necessarily displace. It is not clear to us that the experience would make them better teachers.

Conference Guideline Number Two:

The Department of Energy Facilities' scientists should become involved in the schools as partners with teachers. They should work cooperatively with teachers to develop curricula as well as teaching aids, both at the high school and elementary levels.

Appropriate	Inappropriate	No Response
46%	23%	31%

Some of the respondents who checked "appropriate" for this guideline did so with caution. The following statements typify their concerns:

This activity is appropriate with CAUTION! Laboratory scientists are not curriculum experts. They can be a resource for teachers who prepare classroom materials- for example, explaining concepts, editing and evaluating material for scientific content. However, the majority of the work should be done by experts.

It would seem appropriate only for this to be developed on an individual scientists basis; the Laboratory could encourage and try to facilitate such an activity.

Conference Guideline Number Three:

The Department of Energy Facilities should collaborate with university education departments for two reasons - to provide assistance in training future teachers, and to work as collaborators in developing curricula and teaching aids for the precollege teachers.

Appropriate	Inappropriate	No Response
48%	21%	31%

DOE facilities should not be involved in the training of teachers according to those respondents who stated that Guideline number three was inappropriate:

Training "How to Educate" is not appropriate! Laboratory people should work with the substance (science) of what some precollege teachers deal with, not the process of overtly developing teachers.

If individual scientists wish to work on such projects, it seems appropriate. However, scientists at universities are probably in a much better position to do this type of work.

Conference Guideline Number Four:

The Department of Energy Facilities should conduct an active outreach program. Each facility should develop cooperative relationships with its surrounding communities, through local school boards and other community organizations to clearly define needs and to contribute to the gaining of scientific literacy among the general populace.

Appropriate	Inappropriate	No Response
58%	11%	31%

The reason for the 58% response for "appropriate" under this guideline is seen in the statements made by the respondents:

By cooperating with local school boards and school administrators, we can determine which programs have the greatest impact on improving science education.

This would encourage students to consider science as a career. It would also be a plus in furthering good relations and publicity with the surrounding communities.

Obviously, DOE Facilities have a commitment to the community in which they are located and in which their employees live.

Conference Guideline Number Five:

The Department of Energy Facilities should not limit its involvement with students to those who have been identified as academically talented. All students should be the focus of some selected activities.

Appropriate	Inappropriate	No Response
56%	13%	31%

Although 56% of the respondents felt that this guideline was appropriate, this guideline received the most editorial comments:

If we wish to increase the pool of science students and contribute to the scientific literacy of the general public, then we must be concerned about all students... and young students at that. Research shows it cannot be too early to expose students to exciting science.

All citizens should be at least aware of scientific programs even though not directly involved in them. Further, a spark of interest may awaken latent talents.

Certainly the nature of the U.S. quality of life and success in its maintenance and improvement are dependent upon achieving a level of scientific appreciation among all segments of the population.

An effort should be made to reach students who may not yet have focused on the sciences. Minority and female students should be targeted where possible and logical for the facility to do so. Artificial involvements should not be undertaken, for any group of students.

Many good students would be denied the benefits of interacting with a National Laboratory if National Laboratories only accepted "academically talented" participants. All jobs within a laboratory are not performed by "academically talented" employees.

And then there are those respondents who believe that the fifth guideline is inappropriate.

Given limited resources, one must be selective. Judging from the available pool of graduate students, we are already reaching the mediocre but not the excellent.

"The DOE Facilities cannot do 'something' for 'everyone'."

And there are those who believe that no activities should be developed for precollege students of any type.

Although it is not a popular view, I seriously question whether laboratories should have extensive involvement with high school students or lower. I strongly favor orientation programs but I do not favor extended "students play scientists" programs.

In summary most of the respondents think that the guidelines suggested during the 1984 conference on precollege science education are appropriate for implementation at DOE Facilities. The inappropriate responses ranged from 11 percent to 23 percent, less than 1/5 of all the responses. Although the "No Response" percentage remained constant for each guideline (31%), the "No Response" population changed for each guideline.

On Site Visits

Interviews were conducted with precollege personnel at the six facilities selected for on-site visits. Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest Laboratory were visited during the months of October and November, 1987. In addition to clarifying some of the items in each respondent's questionnaire each respondent was asked to describe precollege programs that were specifically targeted to certain populations, i.e., minorities, females, and handicapped. They were also asked whether there should be uniformity in the DOE Facilities' precollege programs and which precollege activities should be offered or expanded if funds were made available.

Responding to the question "Do you offer special precollege programs for minorities, women and handicapped?" All six of the respondents indicated that no special programs were conducted for specific populations but that a certain percentage of openings in the various programs were "earmarked" for minorities but not for female or handicapped students. While the literature expresses the need to increase the rate at which young men and women of all races attain degrees in science and engineering (Research Roundtable, 1987) and the need to institute programs aimed at increasing the participation of women and minorities

in science and engineering (OTA, 1985), the respondent facilities do not focus its programs in this area to any great degree. Typical comments made regarding this issue were:

"Over 50 percent of the people who apply to participate in the precollege programs are minorities."

"Forty to fifty percent of our applicants are women, they are well-represented in our programs."

"We get an overabundance of women applicants, but it is very difficult to find top females for science activities."

In response to the question about specific programs for the handicapped individual, only one of the six facilities reported a program for such students. The other facilities reported no special effort to recruit or include the handicapped student in precollege activities. One facility not included in the on-site visits (Lawrence Livermore National Laboratory) reported the preparation of science video tapes for the hearing impaired

Responding to the question "Should there be uniformity in the DOE precollege activities?." Respondents replied that programs should be developed to respond to the specific needs of the surrounding population. Program uniformity it was stressed, imposed by DOE would tend to stifle creativity and enthusiasm.

In response to the question, "Which precollege programs would you like to offer if additional funds were made available?", the following responses were given:

"School/Business Partnership (Amigo Net)", (Los Alamos)

"A Science Resource Center to hold student workshops (Oak Ridge):

"Extend current programs over a longer period of time".(Brookhaven, Lawrence Berkely, Argonne)

"Curriculum development" (Pacific Northwest).

The on-site visits provided another opportunity to clarify information contained in the questionnaire that was in some cases unclear.

Summary

This chapter presented the history and background of the policies which led to the formal recognition of precollege activities at the DOE Facilities and the findings of the survey focused on the current status of precollege science activities conducted at forty-eight DOE Facilities. These findings covered the number of facilities that offer precollege science education activities; the scope of the precollege activities; the number and kind of participants served, and source and use of funds for precollege activities. In addition the findings from three questions asked of the six DOE Facilities interviewed in the second phase of the data collection were also presented.

CHAPTER V

SUMMARY

Summary of Procedures

The primary purpose of this study was to describe the current status of the Department of Energy's precollege science education programs. Another purpose was to define the policies and/or procedures which served as a catalyst for initiation of formal DOE precollege activities. The following information was gathered in this study: The number of DOE facilities that sponsor precollege programs; the number of precollege activities offered by DOE facilities. the scope of the precollege activities; the number and type of participants served; the funding level required to implement the precollege programs; where the funds come from and how they are spent.

The data presented in this study result from a survey conducted among forty-eight DOE facilities that employed at least twenty professional employees who held advanced degrees. Additional information was obtained as the result of on-site visits and interviews conducted with the precollege personnel at six selected DOE Facilities.

Summary of Findings

Several conclusions were derived from the the data. They are presented here within the context of the research questions.

1. What policies or mandates served as the catalyst for intiating precollege science activities at the DOE facilities?

Initiatives originating in the White House served as catalysts for recognizing precollege educational programs as an official part of the DOE's mission.

The Department of Energy and its predecessor agencies conducted precollege science activities for many years on an informal basis. Not until 1979, when President Carter announced a program of " apprenticeships for minority high school students..." (White House, 1979) were formal precollege science programs initiated at the Department's Facilities. After President Carter provided the spark for precollege activities, President Reagan contributed to its flame by providing fuel in the form of his "National Partnership in Education Program" (White House, 1983), and with supported encouragement from Donald P. Hodell, Secretary of Energy, 1983, and Secretary of

Energy, John S. Herrington, (1985, 1986, 1987).

In the past, approval was given, and Doe was encouraged to use funds for interactions between DOE facilities and universities and colleges. Funds for precollege activities had to come from outside sources or be accrued from operating funds.

President Reagan gave the following tacit approval to DOE facilities to use programmatic funds for precollege education activities:

I am requesting that each Executive Department and Agency...identify a school and establish a partnership with that school...Elements of the partnerships can range from your employees volunteering in tutoring programs to sponsoring field trips and tours, to providing classroom speakers and career awareness seminars. (White House, 1983)

President Reagan's Memorandum officially recognized precollege education as a part of the DOE mission.

2. Which DOE facilities sponsor precollege science education programs?

Two-thirds of the Department of Energy's Facilities conduct some type of precollege science program.

The highest percent of participation is found in the Multiprogram Facilities followed by the Enrichment, Production, Testing and Fabrication Facilities. It appears that the Multiprogram Facilities multidisciplinary research capabilities with a large number of "user" facilities, allows for more extensive precollege involvement than any

of the other two major DOE categories.

The greater participation of Enrichment, Production, Testing, and Fabrication Facilities in precollege activities over that of the Program-Dedicated Facilities can be attributed to "the captive audience syndrome" of the former facilities. In general, many of the Program-Dedicated Facilities, which have a single purpose mission, are located within other existing structures, i.e., universities, colleges, which focus much of their "training" efforts on undergraduate or graduate students.

Those Enrichment, Production Testing, and Fabrication Facilities, although engaged in activities which are categorized as "classified" are generally the only scientific entity within a specific geographical area and respond to the precollege science needs expressed by the community by sponsoring precollege activities.

3. What is the scope of the precollege science programs sponsored by the DOE facilities?

The scope and number of precollege activities sponsored by DOE Facilities vary according to the mission of each facility.

The number of activities range from one to twenty-seven. The largest number of activities are offered by

Multiprogram Facilities. This is understandable, as stated earlier, since, with three exceptions, the Multiprogram Facilities are engaged in research activities that can easily accommodate precollege educational needs. The three exceptions are facilities which not only engage in basic research, but also are involved in developing and producing nuclear weapons. In these instances, site access becomes complicated for those persons who lack the proper "clearance", and precollege offerings are somewhat limited.

The range of precollege activities offered by those facilities whose prime missions focus on experiments with nuclear reactors, accelerators, or uranium production and enrichment are somewhat also limited in the number sponsored. Many of these facilities not only require special "clearance" for site access, but also have minimum age requirements.

The scope of precollege activities offered at the DOE Facilities can be categorized in the following manner:

1. Research Participation
2. Workshops and Institutes
3. Curriculum Development, Instructional Materials
4. In-House Tours, Lectures, Demonstrations
5. Classroom Direct Instruction, Lectures
6. Community/Professional Outreach
7. Special Events
8. Ad Hoc Support Activities

4. What are the sources of precollege education support funds and how are they used?

The Department of Energy provides little direct financial support for precollege activities. Most of the funds received are used to pay stipends to the participants and for salaries to persons hired to assist in the precollege programs.

Although the Department of Energy strongly recommended the facilities participation in precollege activities, little direct financial support is provided to ensure implementation of programs. Most of the facilities receive a large amount of the funds needed to operate their programs from the individual facility's operating budget. The Department's directives encouraging its facilities to increase precollege activities has not been supported with increased funding. In fact, when increased funding is requested for precollege program expansion, the DOE facility is often directed by DOE to take the needed funds from the facility's operating budget.

The DOE precollege science programs continue to be funded (except for the High School Honors Program) in the manner as they were prior to receiving recognition by DOE as an essential part of the Department's mission. The absence of DOE funds for precollege activities precludes DOE governance and control of these activities.

5. To what extent do the DOE facilities agree on the appropriateness of the guidelines developed during the 1984 DOE Precollege Conference?

The guidelines developed during the 1984 DOE Precollege Conference are deemed appropriate for implementation at the individual facilities.

The results of the survey confirm that these statements are valid general guidelines for DOE facilities to follow during implementation of precollege activities. The guideline focusing on the facilitation of scientific literacy among the general public was considered to be the most appropriate by the respondents. The high response rate to this guideline may be due to vested interest. Scientists believe that a science-literate public would give support to "good" science-related policies and thus, provide more money for research.

Other Findings

The findings presented in this portion were either derived from items listed in the survey instrument, but not included as part of a research question, or from information acquired as the results of the on-site interview process.

Little effort is expended to attract student populations that are underrepresented in the science and engineering professions.

Few, if any, DOE precollege programs are specifically designed to attract the minority, female or handicapped student. Although the formal recognition of DOE precollege programs was initiated by a program to increase minority students in science and engineering and 56% of the respondents in this study deemed it appropriate to expend efforts to include minority and female students in the precollege activities. The lack of a commitment by DOE personnel to include minority and female students in precollege activities can be contributed to several factors: 1) Many of the Department of Energy's scientists believe that there is an unending supply of qualified young people who will pursue science as a career; 2) These same scientists believe that these "best and brightest" students should have an opportunity to experience the uniqueness of the DOE research and development facilities; and 3) since Female and minority scientists are a very small percentage of the scientific research and development staff, scientists believe that females and minorities do not have the ability to work in the field and little effort should be expended to include them in DOE activities. The local precollege personnel capitulate to the norms of the organization and make no special effort to include the underrepresented groups.

Most of the DOE Facilities lack dedicated precollege science education facilities.

Dedicated on-site precollege education facilities (classrooms, science centers, etc.) are more the exception than the rule at the DOE facilities. When responding to the survey item concerning science centers, many of the respondents indicated that their facility had a science center. But subsequent on-site visits and follow-up phone conversations indicated that in most cases the "Science Center" was a not a room or building specifically dedicated to precollege activities, but a shelf in a bookcase, a table in a hall for books and other materials, and in one case, a drawer in a file cabinet. In those instances where a science center existed at a facility, the center was located remote to the research and development areas. In addition to the lack of science centers, the majority of the DOE Facilities lack specific dedicated precollege laboratory space. On-site visits revealed that precollege activities were either planned so as not to coincide with the use of facilities being used by professional staff, or were held off-site in science centers, schools, community halls, and other physical facilities available in the surrounding community.

The majority of the precollege science education programs offered at the DOE facilities are operated under a decentralized administration system.

In general the precollege activities offered at the various DOE Facilities, are not managed, or coordinated by one department or division. Only five DOE Facilities have assigned the responsibility for precollege activities to single department or division. Only one of the five facilities has full-time precollege personnel. The other personnel who plan and implement precollege activities do so in addition to other primary responsibilities. Coordination of precollege activities is conducted by such diverse organizational units as educational divisions, public affairs offices, human resource departments, equal employment opportunity departments, director's offices, and individual scientific divisions. Thus, it is conceivable that DOE precollege personnel at a single facility has no knowledge of all the activities offered by the facility.

Conclusions from the study

The following conclusions were derived from this study:

1. The directive from the Reagan Administration to the DOE Facilities to become active in precollege education activities had little effect on the programs offered. Pre-college activities were in place at the individual facilities prior to encouragement from the White House to do so. The extent to which precollege activities occur at the individual facilities appears to be directly related to the facility director's interest in and his commitment to pre-college science education. Nowhere is this more evident than in the area of funding for these activities where almost 70% of the financial support is derived from resources under the control of the facility's director. The official recognition of precollege education as an integral part of the DOE mission brought no supportive funds to institutionalize the programs.

2. With one exception, the facilities that provide the largest number of precollege activities are those

identified as Multiprogram Facilities. The one exception is a facility found in the Program-Dedicated category, where the program is operated as a separate entity from the DOE Facility, and its personnel are not DOE employees. The Multiprogram facilities are able to accommodate a larger number of precollege activities because of large operating budgets in which precollege funding can more easily be absorbed; a large number of scientific personnel, and a diversified mission which provides more flexibility and precollege activities can be readily incorporated into ongoing research areas.

3. The majority of the professional personnel participating in the precollege science education activities at the DOE Facilities are not practicing DOE scientists and engineers. In most instances the personnel that relate to the precollege participants are either high school science teachers, university professors or graduate students hired specifically to assist in the precollege activities. It is generally the science teacher, university professor or graduate student who provides the day-to-day contact and hands-on directions to the participant. Contact with the research scientist is quite limited. The professional scientist may provide a lecture or demonstra-

tion, but are seldom available on a continuous basis during a scheduled precollege activity. In those instances where the precollege activities are conducted at off-site locations profession research scientist might never be present. Thus, in most of these situations the precollege participant at a DOE facility never has the opportunity to be inspired by a creative scientist and therefore become more technically competent as supported by Gray (1987).

Recommendations From the Study

The following recommendations are preffered based on the information compiled during this study.

1. Federal or private long-term, stable funding sources to support DOE precollege activities should be sought. Lack of funds restrict the number, scope and size of programs. Funds should be made available for equipment purchase and maintainence. In addition, stability in financial resources would allow for increasing the number of participants and long range programmatic planning and evaluation.

2. DOE precollege activities for elementary students and teachers should be expanded. Research suggests that early school years are critical in recruiting students to the sciences. Many young students develop negative attitudes about science before they reach high school. Since the largest number of individuals who participate in the DOE precollege programs are elementary students, great effort should be mounted by DOE to develop science-literate elementary teachers and enthusiastic students.

3. Arbitrary restraints placed on the participation of underrepresented groups in precollege science programs should be identified and corrected.

The need to increase the rate at which people of all backgrounds attain science and engineering degrees coincides with the projected lack of the "traditional" science student. Since one of DOE's missions is to ensure the development of scientific and engineering talent for the future it is important that increased attention be paid to those groups with historically weak participation rates in science and mathematics. DOE should expend efforts to identify the factors leading to reduced participation by women and minorities and initiate precollege programs that reach all students and stimulate each to achieve an understanding of science, mathematics and technology that is limited only by talent and temperament, not by gender or race.

4. The imposition of "uniformity" in precollege science education offerings by the Department of Energy should be discouraged.

Individual DOE facilities should be encouraged to sponsor programs unique to their particular environment. Uniformity of DOE precollege science programs is not

desired or recommended. "Precollege programs offered at each facility should be as the result of the community's expressed needs and the availability of appropriate resources at the DOE facility." The lack of direct financial support for precollege programs from DOE precludes their control over the individual facility's programs.

Recommendations for Further Study

In view of the results of this study the following objectives for further research are recommended:

1) To substantiate the results of this study.

This study was the first to be conducted on the status of DOE precollege education programs. There is a need to replicate the study, using the same and different criteria for population selection, to determine whether or not the results are specific to a particular "window" in time or if present conditions are constant.

2) To determine the appropriateness and effectiveness of the precollege activities sponsored at the DOE Facilities.

An analysis should be conducted at each facility to determine if the type of resources available (human and equipment) and the kinds of activities offered address the science and technology needs as defined by the local education. There is a need to determine local consensus on what should be done to improve the community's science and technology education. There is also a need to evaluate the programs to determine the academic merit of the activities offered.

3) To define ways to coordinate the precollege science education efforts of DOE with other organization concerned about the status of the Nation's science education in the elementary schools.

Making a substantial improvement in the quality of elementary school science education is a formidable task, but it must be done. There is a need to bring together qualified technical professionals to provide guidance and participatory leadership to the national effort to raise the quality of science instruction received by elementary student.

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APPENDIX A

APPENDIX A

Sample Population

Ames Laboratory

Argonne National Laboratory

Associated Western Universities

Bates Linear Accelerator Facility

Bettis Atomic Power Laboratory

Brookhaven National Laboratory

Center for Energy & Environment Research

Coal Fire Flow Facility

Environmental Measurements Laboratory

Fermi National Accelerator Laboratory

Goodyear Atomic Corporation - Portsmouth Gaseous
Diffusion Plant

Hanford Engineering Development Laboratory

Idaho National Engineering Laboratory

Inhalation Toxicology Research Institute

Knolls Atomic Power Laboratory

Kansas City Plant Allied Corporation

Laboratory for Energy-Related Health Research - University
of California

Laboratory of Biomedical & Environmental Sciences -
University of California

Lawrence Berkeley Laboratory

Lawrence Hall of Science

Lawrence Livermore National Laboratory

Los Alamos National Laboratory

Martin Marietta Energy Systems, Inc. - Y-12 Plant

Michigan State University (MSU)-DOE Plant Research
Laboratory

Monsanto Research Corporation

Morgantown Energy Technology Center

New Brunswick Laboratory

Northwest College & University Association for Science

Notre Dame Radiation Laboratory

Oak Ridge Gaseous Diffusion Plant

Oak Ridge Associated Universities

Oak Ridge National Laboratory

Pacific Northwest Laboratory

Paducah Gaseous Diffusion Plant

Pantex Plant

Pineallas Plant General Electric Company - Neutron Devices
Department

Pittsburgh Energy Technology Center

Princeton Plasma Physics Laboratory

Radiobiology Laboratory

Rocky Flats Plant - Rockwell International Energy Systems

Rockwell Hansford Operations Reprocessing & Waste
Management

Sandia National Laboratories

Savannah River Ecology Laboratory

Savannah River Laboratory

Solar Energy Research Institute

Stanford Linear Accelerator Center

Stanford Synchrotron Radiation Laboratory

United Nuclear Industries

APPENDIX B



Dear DOE Contractor:

The Department of Energy has responded to needs in science education in many ways. A full range of educational programs have been developed at the college/university level. New attention is now being focused on needs in pre-college science education. In this context, it is important to understand the current Contractor efforts at this level.

DOE and the Energy Research Advisory Board have asked Argonne to collect such information and report the extent to which DOE contractors are involved in pre-college science education. So that we can provide a comprehensive report, I urge you to complete and return this survey.

A pre-addressed envelope is enclosed for your convenience. Please return this questionnaire by August 15, 1987. Thank you for your cooperation in this important task.

Sincerely,

A handwritten signature in cursive script that reads "Juanita Thomas".

Juanita R. Thomas
Division of Educational Programs
Argonne National Laboratory

1987 SURVEY OF DOE CONTRACTOR PRE-COLLEGE SCIENCE EDUCATION ACTIVITIES

The purpose of this survey is to determine the extent of pre-college education programs offered at the DOE Contractor Facilities. The information collected by this survey will be used to provide a comprehensive report of status and needs in pre-college education to DOE so that the Department can determine the most effective approaches to develop the nation's scientific talent at the pre-college level.

I. GENERAL INFORMATION

This survey has been coded so that it is not necessary to provide information about your facility. Please indicate to us, however, if there are unique characteristics about your facility that affect the pre-college science education activities or provide any other background information you think would be useful to us.

Individual completing this survey.

Name: _____

Title: _____

Address: _____

Telephone: _____

(area code)

II. PRE-COLLEGE ACTIVITIES CURRENTLY BEING CONDUCTED

Listed below are pre-college activities often offered by DOE facilities. Please indicate those activities conducted by your facility during FY 1987 and numbers of participants.

PRE-COLLEGE ACTIVITY	Mark an "x" in space if conducted in FY 1987	Number of Teachers and Students Involved			
		TEACHERS		STUDENTS	
		Elem/ Middle	High School	Elem/ Middle	High School
1. Lectures - one-two hour scientist presentations to groups <u>outside the facility</u>					
2. Lectures - one-two hour scientist presentations to groups <u>at the facility</u>					
3. Demonstrations - R&D personnel go into classrooms to demonstrate scientific principles					
4. Workshops - hands on experiences at the facility					
5. Tours of the facility					
6. Research Participation - students and/or teachers work with individual scientists in their laboratories					

The following are activities and facilities that do not have individual participation. Please indicate if they are a part of your pre-college program.

- 1. Science Center - Exhibition Hall have do not have
- 2. "Adopt a School" Program have do not have
- 3. Development of teaching materials have do not have
- 4. Other related activities: _____

The following are pre-college activities designed for a specific group. Please indicate those conducted in FY 1987, how many participated and how the participants were recruited.

PRE-COLLEGE ACTIVITY	Mark an "x" in space if conducted in FY 1987	Number of participants	How are participants recruited?
1. Summer research participation assignments for high school students			
2. Summer classroom/laboratory experiences for high school students			
3. Explorer Scout Program - involve high school students in science activities			
4. Science Bowl - competition between high school teams on scientific matters			
5. Saturday Programs for high school students			
6. DOE-High School Science Honors Program - two week summer program			
7. Institutes for high school students			
8. Institutes for science teachers			
9. Summer jobs for teachers			

IV. GUIDELINES FOR PRE-COLLEGE ACTIVITIES AT DOE CONTRACTOR FACILITIES

In the Fall of 1984, a conference focused on the role of National Laboratories in pre-college science education was held at Argonne. As a result of the conference, guidelines for conducting pre-college activities were developed. We would appreciate your review of these at this time and indicate to us which guidelines are appropriate or inappropriate in developing pre-college programs at your facility and explain why this is.

1. The National Laboratories should focus on programs that revitalize pre-college teachers through having them spend internships with laboratory scientists during the summer. Institutes and in-service training should be conducted throughout the academic year.

appropriate

inappropriate

2. National Laboratory scientists should become involved in the schools as partners with teachers. They should work cooperatively with teachers to develop curricula as well as teaching aids, both at the high school and pre-high school levels.

appropriate

inappropriate

- 3. The National Laboratories should collaborate with university education departments for two reasons—to provide assistance in training future teachers, and to work as collaborators in developing curricula and teaching aids for pre-college teachers.

appropriate inappropriate

- 4. The National Laboratories should conduct an active outreach program. Each laboratory should develop cooperative relationships with its surrounding communities, through local school boards and other community organizations to clearly define needs and to contribute to the gaining of scientific literacy among the general populace.

appropriate inappropriate

- 5. The National Laboratories should not limit their involvement with students to those who have been identified as academically talented. All students should be the focus of some selected activities.

appropriate inappropriate

THANK YOU FOR COMPLETING THIS SURVEY. Please mail it using the pre-addressed envelope to:

Juanita R. Thomas
Division of Educational Programs
Argonne National Laboratory
Argonne, Illinois 60439

APPENDIX C

SURVEY GUIDE

1. DO YOU HAVE SPECIAL PROGRAMS FOR MINORITIES?

WHAT ARE THEY?

HOW ARE PARTICIPANTS SELECTED (RECRUITED?)

HOW MANY PARTICIPANTS ARE INVOLVED EACH YEAR?

2. DO YOU HAVE SPECIAL PROGRAMS FOR WOMEN?

WHAT ARE THEY?

HOW ARE PARTICIPANTS RECRUITED?

HOW MANY PARTICIPANTS ARE INVOLVED EACH YEAR?

3. DO YOU OFFER PROGRAMS FOR HANDICAPPED?

WHAT ARE THEY?

HOW ARE THE PARTICIPANTS SELECTED (RECRUITED)

HOW MANY PARTICIPANTS ARE INVOLVED EACH YEAR?

4. ARE SPECIAL EFFORTS EXPENDED TO ENSURE PARTICIPATION OF MINORITIES, WOMEN AND HANDICAPPED IN THE REGULAR PRE-COLLEGE ACTIVITIES?

5. DO YOU HAVE DEDICATED FACILITIES FOR PRECOLLEGE ACTIVITIES?

6. DO YOU USE OUTSIDE FACILITIES FOR PRECOLLEGE ACTIVITIES?

KIND (SCHOOLS, COMMUNITY CENTERS, ETC)

7. DO YOU EMPLOY TEMPORARY PERSONNEL TO ASSIST WITH PRECOLLEGE ACTIVITIES?

TYPE (HIGH SCHOOL TEACHERS, UNDERGRADUATE STUDENTS, GRADUATE STUDENTS, COLLEGE FACULTY)

8. SHOULD THERE BE UNIFORMITY IN THE LABORATORIES' PRECOLLEGE ACTIVITIES? (SHOULD ALL LABS OFFER IDENTICAL ACTIVITIES?) IF YES, WHAT SHOULD THEY BE?

9. IS THERE SOME ACTIVITY THAT YOU ARE NOT PRESENTLY OFFERING THAT YOU WOULD IF GIVEN THE OPPORTUNITY?

WHAT IS IT?

APPROVAL SHEET

The dissertation submitted by Juanita R. Thomas has been read and approved by the following committee:

Dr. Max A. Bailey, Director
Associate Professor, Educational Leadership and Policy Studies, Loyola

Dr. Philip Carlin
Associate Professor, Educational Leadership and Policy Studies, Loyola

Dr. L. Arthur Safer
Associate Dean, Educational Leadership and Policy Studies

The final copies have been examined by the director of the dissertation and the signature which appears below verifies that fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

April 20, 1988
Date

Max Bailey
Director's Signature