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PRECOLLEGE TEACHERS PROGRAM AT THE LAWRENCE BERKELEY LABORATORY

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August 1984

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Summary Report

PRECOLLEGE TEACHERS PROGRAM AT THE LAWRENCE BERKELEY LABORATORY*

August 1984

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INTRODUCTION

This report describes the summer teacher program at the Lawrence Berkeley Laboratory and to draw some conclusions regarding its value and effect on the participating teachers. The identification of secondary school science teachers with science and technology, from basic research to product development or medical advances is an important goal leading to improved science education in this country. This identification or association with the process of scientific progress is not only missing in the minds of the general public but in the minds of the teachers as well. Recognized institutions of science and engineering such as a national laboratory by their very nature can serve to reawaken this sense of connectedness between the classroom and the high-tech world each of us must assimilate and in which we actively participate. The format used in the summer teacher program at LBL appears to be effective in accomplishing this goal.

The Lawrence Berkeley Laboratory (LBL) has a history of involvement in education. This is in large part due to its close proximity and strong academic ties to the Berkeley Campus of the University of California. There has been a growing recognition that science and math education in the primary and secondary school levels is in need of help. The national laboratories are unique institutions of public research activity and could be important resources to the teachers' needs. The approach that was taken in the first year of this project was to bring highly qualified, experienced science teachers into the Laboratory environment, have them explore and use the resources of the Laboratory, and make recommendations for future programs to meet the needs of secondary school science teachers. At the same time, the program was designed to offer the teachers an opportunity for professional growth and personal enrichment in a specific field of science. It is the hope of the original program planners at LBL that the contacts between the Lab scientists and participating teachers will be a lasting one and serve to open the doors of the Laboratory to qualified secondary science and math teachers.

The Lawrence Berkeley Laboratory held summer programs for secondary school teachers in the summers of 1983 and 1984. The general format for each of the programs was to have the teachers spend approximately one half of their time in an assigned research laboratory. The other half of the teachers time was used to explore laboratory resources, to attend lectures and seminars, as well as to develop curriculum. One important goal of the 1983 summer program was to evaluate the Lawrence Berkeley Laboratory as a potential resource for secondary school teachers. A report was written during the sixth and last week of the program entitled "THE ROLE OF A NATIONAL LABORATORY IN SECONDARY SCHOOL EDUCATION". The report, edited and without appendices, appears in PART I under the same title. The overriding response from all of the participating teachers the first year, was self identification with scientific research along with a feeling of renewal, and vitalization for the teaching profession. This response resulted in large part from the teachers individual association with a research group, and the rich environment of research activity characteristic of National Laboratories. The 1984 summer program aimed at teacher renewal and

vitalization by again assigning teachers to research groups in the laboratory. In addition the teachers were asked to develop short units for use in a junior or senior high classroom. A summary and analysis of the 1984 summer program is given in PART II.

The two summer programs had some distinct differences. The first year six Bay Area high school teachers were selected from five school districts. The teachers were accepted into the program based on the recommendations by the school district superintendents, or their representative. These first year teachers were selected based on their ability to evaluate LBL as a resource to science education. The teachers in the 1984 summer program were also recommended by the superintendents, or their representative, but with the focus on individual renewal and the development of curriculum. This resulted in two distinctly different groups. Many of the teachers in the first year headed their departments and had experience in dealing with school administration and representing other science teachers. This level of responsibility was not generally true of the second group of teachers. While the first group of six was comprised entirely of high school teachers, the second group of eleven, was comprised of two high school teachers returning from the first year, plus three other high school teachers, and six junior high school teachers. One important qualification of the teachers from both groups was that they had received their bachelors degrees in science. The research group assignments were based in large part on their academic training.

The program at LBL is in the process of discovering ways to assist with improving science education in secondary schools. There are three groups of science teachers or potential science teachers that need to be reached: The science teacher formally prepared to teach in one of the areas of science, teachers with no formal training but given teaching assignments in science, and college students chosing careers in science and engineering. It is the first group that has made up the participants in the past two years program. Ways to reach the second and third group need to be explored. Another issue is how best to propagate the positive effects of the program to the largest number of teachers. One approach being tried is through the development of a directory of staff scientists and teachers desiring opportunities for interaction. Finally an important aspect of any program attempting to induce change should be self evaluation to determine its effectiveness in attaining its stated goals. This is a formal process and one LBL hopes to develop in conjunction with the School of Education at the University of California Berkeley.

PART I

THE ROLE OF A NATIONAL LABORATORY IN SCIENCE AND MATHEMATICS EDUCATION

Recommendations by Six Secondary Education Teachers
Representing the San Francisco Bay Area

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Six high school teachers representing five Bay Area school districts participated in a six-week program. Part I is their report. Their evaluations and recommendations come out of the very personal and human daily struggle to teach science in an environment that often lacks support and recognition of the importance of the task. It should not be surprising, therefore, that one of the most important benefits the teachers felt they derived from their six weeks at the Laboratory was an increase in their own self esteem as science teachers and a renewed enthusiasm for science and science education.

A. FOREWORD

We are a "Nation at Risk". The shortage of technologically oriented individuals and the growing scientific illiteracy of a large segment of our society is exacerbated by the current shortage of qualified science and mathematics teachers. In this highly competitive world, there is a growing realization that we can no longer allow this condition to continue and must find a way to increase the number of motivated science students and qualified science teachers. In response, the Department of Energy has provided support to the Lawrence Berkeley Laboratory to establish a committee of secondary teachers to survey the Laboratory's facilities, evaluate the Laboratory's potential to interact with high school teachers in enhancing the quality of education, and recommend a variety of both short and long-range programs to address this problem of critical need.

It is rather ironic that while schools and teachers are receiving criticism from many sources, there has been little or no attempt to help the schools and teachers with their problems. Although most of the criticism is quite justified, the solutions to the problems are very often beyond the control of both the schools and teachers. The philosophy of "pulling oneself up by the bootstraps", which is so popular today, will not work in most public schools. The help that is required must take a variety of forms. The Lawrence Berkeley Laboratory and other national laboratories are in a position to give some of the help that is so desperately needed.

One of the problems facing secondary schools is the erosion of standards and the related problem of low teacher morale. By making the research at LBL and other national laboratories available to teachers, the teachers can become better informed in science and mathematics and at the same time they would have an experience that would give their morale a real boost.

We the participating teachers feel that LBL as a national laboratory is in a uniquely favorable position to help a significant number of the basically well-prepared teachers by giving them the opportunity to work with an active research group, or to participate in summer institutes which are designed to acquaint them with the variety of current research conducted.

The various suggestions that we put forth in this report should serve several groups of teachers and would also help raise the high school student's interest in science and mathematics. Hopefully, the programs started by LBL could serve to get other institutions involved in helping the science and mathematics programs in their local schools.

Two important issues that we do not address in this report are what can be done by working directly with high school students at LBL and what can be done for science teachers with little or no formal education in science.

With respect to high school students, LBL currently has an ongoing program supported by DOE. This is an important area but not one the committee was asked to evaluate. However, a special series of occasional Saturday science meetings designed to inform and motivate high school students should increase their interest in science and encourage them to take more science courses in their schools. Many high school students have no concept of what science is or what scientists do. If the lectures were followed by appropriate tours, the students would acquire a better picture of science. These programs would be especially important to the minority students who have not really considered science as a profession and who have not seen the need to take a solid academic program in high school in order to prepare for a science major in college. The second problem of properly upgrading science teachers with less than adequate training in science or math is discussed later in the report.

B. OVERVIEW OF SUMMER ACTIVITIES

In April of 1983, several members of the Laboratory involved in educational activities were requested by DOE to submit a proposal for working with high school teachers and students in the area. It was decided that the pilot program for the teachers should be an evaluative study of the Laboratory by high school teachers. A six week program was outlined and funded. The superintendents of five school districts in the Bay Area were asked to recommend one teacher with both the appropriate experience and interest for the evaluative program. Based on these recommendations, five teachers were selected and hired by the Laboratory, and a sixth teacher also participated in the program and was supported by the Oakland School District.

The program was designed so that the teachers would spend approximately fifty percent of their time associated with a specific research group working in an area of the teacher's current interest and educational background. Thus, each teacher was matched with an individual scientist and spent five weeks participating in laboratory research work, observing ongoing work at LBL, and attending seminars, lectures, and tours of LBL and UCB. The teachers met with administrators from LBL, UCB, LHS, and other members of the science community to discuss problems of science and math education and their possible solutions. A complete list of the activities accomplished by the teachers in this program follows in Table I . The group met at the end of each week to share information and to establish a schedule for the following week. The sixth week was spent correlating data and preparing recommendations based on experience.

This was the first year that LBL attempted to have a program for high school teachers. As a result of relatively late dates for request, submission, and approval of the proposal, it was not possible to identify each of the participating teachers well enough in advance to guarantee an optimal match with one of the project leaders at LBL. It is particularly important to provide sufficient lead time and orientation to both the participating teachers and laboratory staff.

Our goal as participating teachers was to determine critical needs in science and math education and to identify those that could be filled at Lawrence Berkeley Laboratory. We listed areas that we perceived to be of interest for investigation in meeting their overall goal, and spent a week surveying facilities and making contacts with staff scientists. Based on these areas of interest, we hoped to:

1) Gain exposure to ongoing developments in science and math.

2) Identify teaching aids.

3) Broaden our scientific background outside our areas of expertise and identify opportunities for other teachers to do the same.

4) Investigate opportunities for the development of teacher training programs coordinated between LBL, LHS, and UCB.

5) Develop lines of communication between staff scientists and teachers.

6) Identify opportunities to provide for teacher interactions.

TABLE I

OUTLINE OF SUMMER ACTIVITIES - 1983

A. Research Participants
   (1) Using techniques of analyzing indoor air quality for the detection of hazardous chemicals.
   (2) Constructing and maintaining of microcosm to study acid rain.
   (3) Building apparatus for dispensing small particles for solar energy absorption.
   (4) Assisting in surgical experiments involving transplants. Preparing solutions to be used in certain experiments. Testing a procedure for releasing an amino acid suspected of increasing the incidence of fibrosis in lung tissue. Conducting experiments at Cyclotron and Bevatron.
   (5) Using gas chromatograph and mass spectrometer for analysis of volatile substances.
   (6) Using computers to collect and analyze data in a $\beta+$ followed by two proton disintegrations.

B. Tours and Lectures at LBL
   1) 88 in. and 184 in. cyclotrons
   2) Bevatron (including medical cave)
   3) Linear accelerator
   4) Computer center
   5) Information search center
   6) Library
   7) Salvage center
   8) Salvage processing office
   9) Electron microscope
   10) Chemical biodynamics laboratory
   11) Energy efficient lighting
   12) Neutron activation
   13) Counting techniques in nuclear chemistry
   14) High resolution gas chromatography
   15) DNA cloning
   16) Scanning electron microscope
   17) CIRA

C. Meeting with other teachers in program to share ideas

D. Tours of Participants' Research Projects

E. Special Lecture Series Provided by LBL
   1) Dr. Seaborg - New Elements
   2) Dr. Bissell - Cancer Cells and the Differentiated State
   3) Dr. Calvin - Energy Ariculture
   4) Dr. Novakov - Carbonaceous Particles in the Atmosphere
   5) Dr. Lester - Computational Chemistry

F. Other Special Lectures, Tours and Meetings
   1) Cosmic background radiation
   2) Cancer-producing agents that are created in the cooking of meat
   3) Tour of the "Calvin Laboratory"
   4) Tour of the nuclear reactor on UCB campus
   5) Audited lectures on campus
   6) Meetings with Science Educators from local Colleges, Jr. Colleges and Universities

G. Summary of Student Employment Programs at LBL for High School and College Students

H. Seminars on College Student Research Projects

C. CONCERNS AND PROBLEMS FACING SECONDARY SCIENCE AND MATHEMATICS EDUCATION

There is considerable discussion about the problems confronting public education. It was our opinion that in order to place the Lawrence Berkeley Laboratory in proper perspective as a facilitator to secondary mathematics and science education, we first needed to outline the major problems confronting us; then direct our attention to those concerns that which LBL can help to alleviate. Below is a prioritized discussion of those key problems that science teachers face today.

Lack of Financial Support

Although LBL cannot be instrumental in solving the major problem, which is shortage of money, it is important to give this problem consideration in the text of this report for it is the one problem from which many other problems are spawned. Shortage of funds to run an efficient educational program result in low salaries. The situation is compounded by the fact that the teachers' retirement programs are substandard. Coupled with low income, teachers need to seek additional sources of income. Teachers acquire second jobs and therefore have divided interests. The net result is that less time will be spent on curriculum planning. There is little money to purchase books, supplies, equipment, and insufficient funds to maintain equipment and buildings. Professional meetings become difficult to schedule. There is no money for field trips or films. It is no wonder that academicians who vigorously pursue science and math do not pursue teaching as a career. The overwhelming financial "picture" is quite obviously the fundamental problem.

Teacher Shortages

In California, for example, the supply of science and mathematics teachers is falling very rapidly. The California Commission on Teacher Credentialing reports:

Initial Credentials Conferred in Mathematics and Science [1]:

Year	1964-65	1970-71	1980-81
Mathematics	654	889	203
Science	914	1373	305

In 1982, the numbers continued to decline with only 75 mathematics candidates in the California State System and with only 22 mathematics candidates in the University of California system. The data for science was 127 and 47 respectively. [1] In California "The attrition statistics for mathematics and science teachers suggest that we are going to need somewhere between 1,500 and 5,500 secondary mathematics and science teachers. Staffing difficulties associated with this attrition rate may be compounded if the movement to add more mathematics and science to the high school curriculum is successful. Adding just one course in science

or mathematics in each of the nation's schools would require a 20% increase in mathematics and science faculty (40,000 more science and mathematics teachers)." [1]

In his report, "Mathematics and Science Teacher Shortages - What Can California Do?" [2], Professor Guthrie indicates that there are about 20,000 science and mathematics teachers in California's public school system and more science and mathematics teachers are leaving teaching than are retiring. The estimate was that 2,200 teachers are actually leaving secondary science and math teaching every year in California. The number of college students preparing to become teachers will not supply the demand. The largest group of teachers were hired about 25 years ago. This group of teachers should be expected to retire in another 5-10 years. In about 1989, the number of students entering secondary schools should start to increase. [2] The shortage of teachers should be acute then unless there is a major increase in those preparing to become science and mathematics teachers in California.

The teaching profession has fallen into disfavor. In a survey by the National Education Association, it was found that 36% of the U.S. teachers asserted that they would either probably not or certainly would not choose teaching again as a career. Only 21.8% said that they would definitely make the same decision again. This reflects the fact that teachers salaries have not kept up with inflation and that the pay received by those in other professions requiring an equivalent level of education is much higher. In California, the teachers' salaries have declined 15% in purchasing power since 1978-79. [2] It is not too surprising, therefore, that the supply of teachers is declining.

Science Teachers Without Science Backgrounds

There are an increasing number of teachers being drafted to teach science courses with minimal, if any, educational training in a scientific discipline. This is certainly not a desirable situation and it is one that is not easily solved. The teachers without a science background will not be drawn away from the profession by industry. Unless programs are developed to upgrade their skill and knowledge in science or standards are set so that qualified replacements found, they may remain in their positions for many years operating at a substandard level. Those teachers who have poor backgrounds in science or who have poor backgrounds in the subjects that they teach might be helped by summer institutes specifically designed to supply them with a better command of the field of science. All during the latter part of the 1950s and during the 1960s, these teachers could attend the various summer institutes and receive the kind of help that they needed. Today, when the need is even greater than in prior years, there are no programs available to help teachers.

Since education is not the mission of a Department of Energy National Laboratory institutes for upgrading teachers in science and mathematics should properly be carried out at universities and institutions such as the Lawrence Hall of Science. Hopefully, all of the science teachers would, in time, be brought to a level where they could participate profitably in the research environment of a National

Laboratory.

Low Morale

Because of the shortage of funds, the heavy course loads, large classes, and lack of recognition, the teachers have developed a very low morale. Not only is the teacher's self-image low, but the public image has also suffered. In addition, teachers receive very little positive recognition for jobs well done. This effect only serves to further reduce the quantity and quality of science teachers.

Lack of Support Systems

Resources for assisting teachers with their needs are not available. There are few or no inservice institutes or summer institutes. There is no means by which teachers trained in science and math can gain exposure to innovative trends in their area of expertise. Worse yet, there is no help for those teachers who are forced to teach outside of their academic areas and suddenly find themselves developing science and math curricula. Finally, there are no procedures for teachers to have meaningful interchange with other teachers who have developed successful teaching strategies and who teach the same subject in another city, or even nearby school district.

Lack of Student Preparation in the Primary Grades

One of the problems confronting science and math education is that students are not presented with the fundamentals early enough by qualified personnel. We can't shower all our attention and resources on high school science and math education because perhaps by that time it's too late to attract a great number of students to a serious study of these disciplines. We have to attack the problem at every level, not only in the last four years of a twelve-year process.

REFERENCES

1) Commission on Teacher Credentialing, State of California, The Mathematics and Science Teacher Shortage, p. 1 (1983).

2) James W. Guthrie and Ami Zusman, Mathematics and Science Teacher Shortages - What Can California Do?, Institute of Government Studies, University of California, Berkeley, pp. 4-5 (1982).

D. CONCLUSIONS

As new programs for teachers become readily available, it follows that not only will additional college students be attracted into the teaching professions, but also competent teachers will find it more desirable to remain there.

After considering the problems involved in science education and attempting to develop solutions during the six weeks at LBL, the committee (comprised of the six teachers) arrived at the following conclusions:

(1) There is a well defined need for a program that will invigorate and stimulate renewed enthusiasm in secondary science and mathematics teachers. This is exemplified by the works cited in this report and the expressed concerns of the committee.

(2) LBL facilities can be very effective in alleviating or solving several major problems that permeate science education, especially that of low morale, low self-image, and low public image.

(3) While research programs can serve as a great morale booster for the teachers and provide a learning environment, the research programs can also benefit from the input of teachers.

(4) There are laboratory facilities at LBL that lend themselves to multidisciplinary applications and could be utilized by teachers representing the physical, biological, and mathematical sciences. These facilities might be most effectively used by a well-integrated institute. Such an institute would provide an opportunity for teachers to be exposed to a wide range of experiences and provide the teacher with a wealth of resources for curriculum development.

(5) The program should be responsive to individual needs and should provide options that would allow maximum personal development.

(6) There is a well-defined need for development of solid science education at the elementary level. LBL can address this problem if elementary teachers involved in this program have a strong scientific background.

(7) By paying qualified secondary school teachers during the summer research programs those individuals who formerly sought non-science summer employment would be able to select the far more stimulating and rewarding option of a summer science research position at LBL.

(8) The above conclusions (1-7) are based on the assumption that teachers involved in a program at LBL would have degrees in science or mathematics with sound educational background in their field. It is the opinion of the participating teachers that LBL could not readily address itself to attempting to train science and mathematics teachers who are teaching outside of their area of academic training or have a weak background in science.

In summary, based on our experiences this summer, the benefits associated with an LBL summer employment program are significant. Foremost, LBL can provide an environment in which teachers can participate in a program that will allow training and renewal in areas in which secondary science teachers were originally educated. This would have the effect of increasing self-confidence of teachers, educating them in current research, and improving morale. The end product would be a revitalization of enthusiasm and energy in teachers to expand their present curricula, producing secondary science programs that are reflective of the current scientific issues and state-of-the-art technologies.

Secondary teachers would have the opportunity to participate actively in current research and gain exposure to many new and exciting procedures. If graduate units from the university were also attached to the summer research program, the long-range financial value becomes available since teachers are given yearly raises based on additional college units.

E. RECOMMENDATIONS

The outstanding resources of LBL should be made available to teachers within the framework of the teachers' summer breaks, and optimal use be made of the facilities at LBL. Any program must be directed towards fulfilling needs of the teachers to which the LBL facility could logically address itself.

After reviewing the concerns that have been expressed in this report, surveying the facilities at LBL, observing ongoing programs at the Lab, and drawing the above conclusions, we are making specific recommendations that could be implemented and would assist science and mathematics teachers in the Bay Area. These recommendations could also be applicable to other national laboratories.

We have chosen to recommend a summer program and an extended program. The summer program recommendations would be recurring and involve a different group of teachers each summer. The extended program recommendations are for providing year-round continuity for a larger number of Bay Area secondary school teachers, particularly those who have participated in a previous summer program at LBL.

In addition, it is our recommendation that educational institutions such as the University of California receive grants to support summer institutes. We feel that the summer institutes should be of several types, one of which should be those specifically designed to help teachers who are using the various curricula such as Chem Study, BSCS (Biological Science Study Committee), PSSC (Physical Science Study Committee), Project Physics, etc. There were institutes for these programs in the past, but schools will be facing large changes in the ranks of science and mathematics teachers. These teachers have not received adequate training in the very curriculum they will be teaching.

An institute which would systematically educate teachers in science instruction should be implemented by state colleges and universities. Each year, the schools must hire teachers who have lower academic backgrounds than the teachers that they are replacing. There will be a need for some period of time to bring these new teachers up to the level that should be required for all secondary teachers. This type of institute will be necessary until the schools are able to attract well-qualified college students into the teaching profession.

E.1 SUMMER PROGRAM

Three formats were developed to utilize laboratory facilities, to utilize teachers' time at the Lab, and to take into consideration the various means by which the largest group of teachers representing a great range of abilities and training could best be served. The three formats are:

a) A research program in which participants are actively involved in independent research in conjunction with an ongoing research project at LBL

b) A summer institute program which would be a highly structured, topical approach to conveying ongoing research at LBL. Participants would be involved in a lecture/laboratory environment. The topics chosen would be developed to integrate the physical, biological, and mathematical sciences.

c) A combination research/institute program.

All three recommendations attempt to anticipate problems that may be encountered by teacher participants. It is critical to the success of all three programs that the participants be fully prepared for the program before they begin. They must be given sufficient time to apply to the program and receive their acceptances so that they can plan their summer activities well in advance. The participants must receive stipends and sufficient unit credit to offset summer employment compensation or the free time they would be forfeiting. The program must be presented so that the worth of the program in curriculum ad staff development is attractive and intriguing. After acceptance, groundwork must be established so that the program begins and develops smoothly. If the research program is chosen, it is essential that the range of possible areas for research be presented to participants and that once a match is made between participants and staff scientists that contact be made prior to the initiation of the program. Background information in the way of appropriate bibliographies and/or reprints should be provided to the participants. There must be provisions made that if a research position is unsatisfactory, an adjustment can be made early in the program.

In the institute program, a syllabus providing background reading should be supplied prior to the initiation of the program. The programs must be well structured so that participants feel that they are making efficient use of their time, and the duration of the program should give the participants time to recuperate after the conclusion of their teaching year and time to prepare for their fall assignment. A nine-week program would be optimal to develop a summer program with depth.

At the conclusion of the program, participants should have input into the adjustments made to subsequent programs. Possibly, they could serve as an advisory committee. Participants should also be given options to continue their contacts with the Lab either as researchers in following summers or as participants in future summer programs. However, accommodations must be made so that new participants be given

first choice on programs.

The following are possible formats for the three programs recommended by the pilot group. The optimal situation would be for all three programs to run simultaneously. These three formats are not mutually exclusive and could be coordinated together, providing the opportunity to best meet the individual needs of the participating teachers. However, any one of the three would be very useful and would be received very enthusiastically by secondary science teachers.

SUMMER PROGRAM

E.1.a. Research Format

Description

Teachers will be presented with a list of available current research at LBL from which they will name their preferences. The labs at LBL taking part in this project will be chosen on a voluntary basis according to the interest and needs of the individual researchers. The coordinating person at LBL will match up the teachers and the labs according to interests, scientific background and experiences of the teachers and arrange for interviews. Before the program starts, teachers will be given current literature pertaining to the particular lab they will work with.

When the teachers arrive at LBL, they will meet with their lab contact person and spend time becoming familiar with the lab and equipment. Time can also be taken during this introductory week to become familiar with the LBL plant and the UCB campus. This can be arranged through planned tours of some of the facilities, preceded by lectures and background, and followed by questions and discussions of the tours.

After becoming familiar with their new surroundings and their own labs, the second week will see the teachers starting to spend a good portion of their days working in their own labs starting research work. The nature of the research can take many forms: from individual mini-research projects, through taking over an ongoing part of the research, to acting as a technician and helping others in the lab do their work. This will depend on the previous training and research skills of the individual teachers and also on the degree of complexity of each particular lab.

Teachers should have the opportunity to take advantage of the many seminars, lectures, etc. that are available at LBL Teachers can also visit other teachers' labs to find out what they are doing and/or join in temporarily if they have spare time in their schedules.

Fridays could be a meeting day of either all the teachers in the program or of individual groups of teachers according to disciplines (subject areas of teaching) to discuss progress, concerns, solutions, and to share teaching skills and ideas. Fridays can also be a time for additional tours that the group or small groups would be interested in at LBL, UCB, etc. This might also be a time for seminars directed toward teachers or small teacher groups according to needs and interests.

Towards the end of the nine-week program, the teachers will have a good understanding of the work and significance of their labs. They will have mastered many of the skills required to do this work. From this, they will be able to create some practical applications for their own individual classrooms. At this time, the teachers will share their individual experiences by giving a short talk (15-30 min.) describing their own work for the summer and how they will relate it to their

teaching.

This summer research program can be extended to a one-year program for schools willing to give sabbaticals to teachers who can then work in a research lab for the entire school year as well as the preceding and following summers. This program should be open only to teachers with science degrees in chemistry, physics, biology, mathematics and computer science.

Advantages

1) Teachers will be able to get back to pure science and away from the classroom for awhile. In the classroom the teacher is the "source" of science, whereas in the lab we are learning (receiving) instead of teaching (giving).

2) Teachers will be more accepted and respected by students and community if they not only "teach" science but take part in current scientific research.

3) Teachers will have a sense of accomplishment and worthiness after having gone through a successful summer research program.

4) Teachers could earn units toward advanced degrees for their research work.

5) Teachers can pick up new skills, techniques, and concepts.

6) Teachers' skills, knowledge, and insight may be an asset to the labs. Teachers are naturally curious and therefore are willing and eager to ask enough questions so as to make researchers come up with answers that might be illuminating to the research work. At best the teachers will help solve problems of the lab - at worst they can act as an extra pair of trained hands.

7) Research labs will be able to count on teachers being in the lab for a definite time period each day.

Disadvantages

1) Teachers may be limited to one main area of LBL and working in one main subject area. This will limit exposure to all that LBL has to offer.
2) There may not be enough contact with other teachers.
3) If the lab assignment is nebulous or negative, it could prove to be a very unpleasant experience since this will take up most of the time.
4) This program may attract a narrow group of teachers who are specifically interested in research.

E.1.b. Institute Format

Description

Two of the greatest resources available at LBL are the highly talented staff and the research in which they are involved. The positive aspects of nuclear research and particle acceleration, i.e., the application of nuclear methods to energy and material development problems as well as environmental and health research, are an important focus at LBL and should be incorporated into secondary curriculum. A summer institute is a highly efficient mans of conveying a great deal of information in a minimal amount o time. The institute would be divided into several topical areas which would be presented as minicourses made up of lectures and supporting laboratory activities. The laboratories must be supported by the lectures and must include hands-on participation rather than pure demonstration. In most topical areas, tours of facilities are very appropriate. Before the tours, descriptive preparation must be provided. A syllabus outlining the minicourse would be very useful. Reading assignments would be required. At the conclusion of each minicourse, classroom activities would be presented. These would be shared with the other participants, with all the activities created being compiled into a collection of classroom activities that would be useful to the entire group. The staff developing the minicourses must receive appropriate funding and lead time so that the courses are well constructed. The minicourses should incorporate both the biological and the physical sciences. It should be understood that these are only suggested outlines and are limited in scope by our own experiences.

Advantages

1) Provides a wide variety of hands-on experience that could be related to enriched classroom experiences.

2) Would provide an avenue by which teachers could update their classroom activities based on ongoing research.

3) Allows teachers to be exposed to recent developments in a wide range of research areas.

4) Provides a highly structured time framework by which maximum use of the resources at the Lab could be tapped by teachers.

5) Provides an opportunity to relate theoretical concepts with the actual implementation of the ideas.

6) Allows participants to become familiar with a wide range of instrumentation.

7) Provides a means of conveying a large amount of information in a short period of time.

8) Provides a setting by which teachers are in close contact with colleagues, facilitating idea exchanges.

9) Prevents the possibility of a individual being placed in an unsatisfactory situation for an extended period of time.

10) Would not take away from assistant or technical positions that are normally filled by college students.

Disadvantages

1) Coordination of the program would be difficult without firm financial support for lectures and laboratory facilities.

2) Long lead time to prepare minicourses and ordering materials for laboratory work may discourage staff participation.

3) It may be difficult to implement a multi-disciplinary program that would be suitable for the wide variety of experiences and capabilities of the participants.

4) Would not provide for much independent investigation.

5) Would not provide long term contact with staff members.

6) Would not provide an opportunity for in-depth research of a topic which would provide an understanding of the problem that would be difficult to convey in a lecture/lab situation.

E.1.c. Combination Institute/Research Format

Description

Minicourses would be presented by members of the LBL staff for half the day. The minicourses would be the same format as the seminar institute, but material would be more concentrated. The rest of the day, participants would be involved in independent research under the guidance of a staff scientist. The minicourse schedule would be available to the host scientist so that possible conflicts with research could be alleviated. It is suggested that research be scheduled in the mornings and classes held in the afternoon. At the conclusion of the program, participants would compile a syllabus of classroom activities based on their course work and would also present a seminar based on their research.

Advantages

1) Would allow a blend of the advantages of the institute format, especially that of being exposed to a wide range of topics, with the advantages of in-depth research.

2) Would address a wide range of talents and interests that the participants in the program may have.

3) There may be a need in the Lab for part time research help.

4) Would provide alternative activities if there was lag time in ongoing research.

Disadvantages

1) May fragment time schedules too much so that neither research nor course work would get sufficient attention.

2) Allowing only a portion of the day for research may cause problems in scheduling time slots for long-term experimentation.

3) Developments in experiments are not always predictable and time conflicts cannot be anticipated.

4) Does not allow for flexibility to participate in ongoing experiments in individual laboratories when conflicts develop between minicourse schedule and research schedule.

E.2 EXTENDED PROGRAM RECOMMENDATIONS

The following suggestions for an extended program are aimed at providing continuity for teachers who have participated in the summer program. The use of these programs allows the Laboratory to have a multiplicative impact on the teaching community. All Bay Area science teachers would have the opportunity to participate in the regional science meetings that are proposed. We suggest these be co-sponsored by LBL and the California Teachers Association. The following activities are recommended:

1) Sponsor seminars or workshops throughout the year aimed at updating teachers on the most recent advancements made in the areas of math and science. These activities would count as university credit or work experience for salary increments. For many years, the California Science Teachers Association sponsored two science meetings a year for the teachers of the Bay Area. These have not been held for years. In order to reestablish the tradition, LBL will provide the major portion of one or more of these meetings. This will include talks by staff researchers and tours through the appropriate laboratories. By being the catalyst for bringing back the tradition of science meetings, the Laboratory could have an impact on the science education in the Bay Area for many years to come.

2) Open lines of communication between communities, LBL staff scientists, and science and mathematics teachers. Examples of ways to do this are:

   a) LBL would organize a directory of teachers in Bay Area school districts and scientists at LBL to match teachers who have technical questions with scientists with corresponding expertise. Copies of the directory would be sent to Bay Area schools and distributed to interested scientists at the Laboratory.

   b) Secure a paid coordinator to organize a Speakers' Bureau for participation in school career education centers and to actively disseminate material to schools regarding the program.

   c) Develop more efficient methods to disseminate information to schools regarding LBL's student/teacher employment programs.

   d) Utilize the LBL public relations department to publicize the programs involving the participation of science and mathematics teachers at LBL.

3) LBL should make surplus (but still functional) laboratory equipment and parts available to teachers in the public schools. These can be used for demonstrations or student projects. Research groups will make a list of usable discards from their labs that can be used in high school laboratories. This equipment will be used as an incentive to entice teachers to attend Saturday lectures. If no equipment is available, teachers will have an opportunity to tour the salvage area for parts that will be useful in the classroom.

4) Due to money shortage in school districts, LBL, in conjunction with UCB, will sponsor periodic How-To-Do-It workshops which would provide teachers with machine shop skills needed for the following:

   a) Building apparatus that can be used in the classroom.

   b) Repairing equipment presently existing in school laboratories.

   c) Operating various newly acquired pieces of equipment.

5) A transportation budget should be established to rent school buses for LBL tours. California school districts have been under such fiscal pressure that almost all of them have discontinued funding any field trips. The field trips that LBL can provide can be a real inspiration to almost all college-bound science classes. With the shortage of funds, very few public schools will be able to make the LBL tours. If LBL had funds to rent buses for the purpose of bringing students to the Lab, tours would be available to even the most economically depressed districts.

6) Create an avenue where a predetermined number of teachers can work at LBL in research capacities during the school year.

7) Development of an Advisory Committee for the purpose of maintaining continuity and upgrading the program. The initial committee will be composed of teachers who were involved in the development of the LBL summer teacher program. Members should serve as a paid consultant/facilitator.

F. SUMMARY

The above recommendations, if developed, would effectively "open the doors" of the Laboratory to qualified science and math teachers. It would create a pool of teachers with a direct and strong connection to interested Laboratory staff and projects. The pool would grow and be renewed each year, and the participating teachers would themselves become a resource for science education in the community. The success of the program would depend upon a sufficient level of support within the Laboratory to provide coordination and management of the programs. In addition, it is essential that partial support be provided to a scientific staff member who has overall responsibility for the program direction and execution, and the writing of a summary report and revised program plan each year.

In summary, the underlying basis of these recommendations is that a national laboratory such as LBL can be responsive to national needs as a source of scientific activity that can be tapped by the teaching community without fear of disturbing the ongoing research or the primary mission of the Laboratory.

Part II. The 1984 Summer Program

A. OVERVIEW OF SUMMER ACTIVITIES (1984)

During the 1983-84 school year, members of the laboratory who had been involved with the Summer Teacher Program of 1983, submitted a proposal for a more extensive program for the summer of 1984. A five week program was outlined and funded. It was decided that the selection of teachers would include both high school and junior high school science teachers. Susan Cristancho, a science teacher from Claremont Middle School in Oakland, was hired before the end of the 1983-84 school year. Since Susan had participated in the teacher research pilot program of the previous year, she had a knowledge of the logistics needed to begin coordination of the new program. The superintendents of six school districts in the Bay Area were contacted and asked to recommend one teacher who would benefit from this experience. They were also given the opportunity to recommend more than one teacher if they would be willing to fund them. The Berkeley and Mount Diablo school districts each funded one additional teacher. The program included eleven teachers: five from high schools and six from junior high schools.

This summer program, like last year's, had the teachers working with a specific research group in an area of the teacher's interest and educational background. Whereas last year's program allowed the teachers about 50% of the time to work in their labs, the recommendation was taken from the 1983 group to allow more time in the research labs. This gave teachers more of a chance to get involved in more aspects of their labs' activities. Each teacher was matched with a principal investigator who could offer the most growth and challenge to that particular teacher. Consequently the eleven teachers spent five weeks participating in laboratory research, attending seminars, lectures and tours of LBL and UCB, discussing education and educational problems with invited guests and taking part in peer discussions with teachers from other schools and other school districts.

The teachers in this years program were also involved in preparing curriculum to take back to the classroom based on the work of their research group. The seeding and groundwork for this curriculum took place during the afternoon teacher group meetings which took place three days a week. The group split themselves into two subgroups: biological science and physical science. Each subgroup assigned topics and grade levels to individual teachers so as to end up with the framework for a cohesive progression of a theme from sixth grade all the way through twelfth. The complexity and sophistication of the subject matter increased to match the students'. The biological science group chose "THE CELL" as its main theme, and the physical science group chose "ENERGY". At the end of the five weeks, the teachers presented their prepared curriculum to the entire group for feedback, suggestions and constructive criticism.

Another addition to this year's program was the offering of six semester units from the UCB education department. This will be an ongoing part of our summer program. Peggy Carlock, who teaches Chemistry at Albany High School and who was also a participant in last years teacher program, accomplished this task. Peggy co-coordinated this summer's program and served as liaison between our group of teachers and other

teacher summer programs that took place around the Bay Area.

The goal of this year's teachers was to get involved in current scientific research, become familiar with LBL as a valuable teacher resource, and to use their creative teaching skills to translate their lab experience into a lesson or a teaching unit for their students.

B. Impressions and Recommendations of Teachers:

Strengths

1. Feeling part of a national laboratory community while getting involved in one's field of interest encourages teacher enrichment.
2. Exposure to current research and techniques in the lab environment updates teachers' education.
3. LBL is a reservoir of knowledge and a good resource for Bay Area science teachers.
4. The building of a liaison between LBL scientists and the secondary education community allows the sharing of common goals.
5. Having the leisure and opportunity to use the resources of LBL is like a working vacation for teachers.
6. The program provides an opportunity for a science teacher to take a closer look at the latest advances in the sciences and provides information to take back to the classroom.
7. Teachers have the opportunity to share ideas, problems and successes related to teaching.
8. The program provides an opportunity for teachers to use their skills and science training at a higher level of sophistication than the experience required of a classroom teacher.
9. The flexibility of scheduling resulted in more efficient use of time.
10. The work atmosphere at LBL provides a stimulating and rewarding experience.
11. The LBL scientists welcome the opportunity to explain their work to someone who understands and appreciates it. Teachers are in a position to pass this communication on to their students and their parents.

Weaknesses:

1. The program started too late in the summer and was too short.
2. At the beginning of the program, the description of what participants were to accomplish was ambiguous.
3. Participation in the research labs and production of a written teaching unit is too much to do in five weeks.
4. The written curriculum assignment was not very clear. This created stress and confusion for some participants.
5. There was lack of preparation time due to the uncertainty of funding.
6. The program is limited to a small number of teachers.

Recommendations:

1. Lead time is needed to think about objectives for the summer. Perhaps both the teachers and participating scientists could be selected in the spring and have one or two meetings together at that time.
2. Present the new employee orientation and a more extensive tour of the LBL facility during the first week of the program.
3. The staff could meet in advance with the participating principal investigators to discuss goals and objectives of the program.
4. Receiving background information of the research group's activities in advance of the program might better prepare teachers for more active participation.
5. The first week could remain a general orientation. The second week would leave the teachers free to become totally involved in their research labs. Group meetings and curriculum preparation would begin during the third week.
6. Send a list of placement areas to the teachers in advance and have them select one or two areas based on their experience and or interest.
7. A greater focus on "expected outcome" should be incorporated into the beginning of the program.
8. More time for research is needed.
9. Line up more scientists beforehand to provide more options to teachers.
10. Each participant could present his/her stage of curriculum development to the group each week. This should infuse more "thinking time" into the final product.
11. More exposure to current scientific work at LBL would broaden the summer experience.
12. Afternoon meetings should include more intensive exchanges of scientific concepts.
13. Teachers could meet after the lecture by scientists to discuss new topics.
14. This program would best serve those who are personally motivated to do their own research and studying.
15. If LBL can take the lead in demonstrating to others the value of this program, it's impact on education will be greatly magnified. Imagine the improvement in science education that would be possible if many private industries developed similar programs, using the LBL program as a model.

C. CONCLUSION

At the end of the second year of this summer research program for secondary science teachers, the conclusions reached are succinct:

This is a valuable program for qualified science and mathematics teachers. It offers them the opportunity to step outside the classroom, yet at the same time become better teachers due to the work they are engaged in.

Teachers have a great deal to offer the scientific community. To quote one of the teachers from this summer's program,

"At the beginning of the program I was only thinking of the benefits to the teacher. Now, at the end, it seems to me that we have a great deal to offer each other. Both our jobs, in a sense, are very lonely. The science teacher is very often trying to sell a product that not many wish to buy. The scientist, I sensed, welcomed the opportunity to explain their work to someone who understood and appreciated it. Teachers are in a position to pass this communication on to their students and their parents. So we all come out ahead."

The 1984 Summer Teachers Program followed in successful pattern of a combination of research and educational related activities on the part of the teachers. The sharing of ideas and experiences is an extremely important aspect of the program. It allowed the teachers to get a wider view of the research activities at LBL and to see the varied ways in which they as teachers could participate in these activities. In addition to exchange of research experiences there was an opportunity to exchange ideas and experiences in the teaching of science and mathematics through the development of individual and group goals for the five week program. The main emphasis in this summers program was curriculum development at the junior high level. There were clearly a wide variety of opinions regarding the need for, and approach to this emphasis. The curriculum developed by each participant served in most cases as a starting point for injecting new material into their respective courses. However, discussions and interchanges, along with immersion in a multidisciplinary research environment focusing on current issues in science provided the teachers with an excellent opportunity for reassessing the topics, curriculum material and their attitudes toward science education. All of the teachers appeared to have a renewed enthusiasm for teaching science and for sharing their summers experiences with their students. The success of the program appears to rely on the opportunity for teacher-scientist and teacher-teacher interaction.

The 1984 summer program highlights the need for follow-up and evaluation. The primary value of the summer programs lies in providing secondary school teachers with the opportunity for renewal and vitalization. Evaluative techniques could be used to verify this effect, and to determine its duration. In addition it was clear that the success of the program depends on having qualified experienced teachers as participants. An alternative format could be sought for attracting the better college students into teaching through use of a national laboratory or research institute environment.

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