DOCUMENT RESUME

ED 210 184 SE 035 932

AUTHOR	Brinckerhoff, Richard F.; Compton, Charles A.
TITLE	The Exeter Conference on Secondary School Science Education. (Exeter, New Hampshire, June 15-22, 1980).
INSTITUTION	Phillips Exeter Academy, Exeter, N.H.
PUB DATE	Jun 80
NOTE	34p.
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Curriculum Development; *Science Education; Scientific Enterprise; Scientific Literacy; Secondary Education; *Secondary School Science; Social Problems; *Technological Advancement; Values

ABSTRACT

In June, 1980, 38 secondary school science teachers and 10 specialists met at Phillips Exeter Academy to discuss the state of science education. Conference participants agreed that a crisis in science education exists. Events appear to indicate that the public is telling science teachers that what they are offering in the name of science education is not relevant to American society today. There have been no major changes in the teaching of secondary school science since the curricular reforms of the 1960's although circumstances have changed dramatically since those times. Conferees suggested that new materials, not new courses, need to be created so that material of societal and ethical character could be infused into present science courses, replacing 10% of present course content. They also suggested that a national network of permanent Science Resource Centers (patterned on the County Extension model) should be established to create and distribute teaching materials addressed to societal issues as well as for other tasks. (PB)

The Exeter Conference On Secondary School Science Education

June 15-22, 1980

Phillips Exeter Academy
Exeter, New Hampshire

The names of the participants and consultants will be found in Appendix A on pages 18-20.

THE EXETER CONFERENCE ON SECONDARY SCHOOL SCIENCE EDUCATION

Exeter, New Hampshire
June 15-22, 1980

Phillips Exeter Academy
Exeter, New Hampshire

CONTENTS

PREFACE

This is an account of an unusual conference on the present state of secondary school science education. Held at Phillips Exeter Academy in Exeter, N.H., June 15-22, 1980, the conference brought together thirty-eight carefully selected science teachers from public, parochial, and independent schools from all over the country and ten specialist consultants of high professional standing, all of whom recognized that the state of science education in schools today is a matter of serious national concern.

At issue was the efficacy of American secondary school science programs in the preparation of citizens adequately prepared to face the demands of contemporary society. At the end of the week's intensive discussions, their conclusions were practically unanimous, simple, and susceptible to immediate implementation. Such consensus among forty-eight teachers and scholars on a national issue gives us the courage to address this report to the widest possible audience as a call—an exhortation—to further action and implementation

Richard S Aaronian
Richard F Brinckerhoff, *Chairman*
C Arthur Compton
Andrew A Polychronis

Science Department
Phillips Exeter Academy
Exeter, N H 03833

SUMMARY

Thirty-eight secondary school science teachers from all over the United States convened at Phillips Exeter Academy in June, 1980, to discuss with ten specialists what they considered to be a crisis in science education Since the National Science Foundation supported curriculum reforms in the 1960's, almost no change has taken place in the content or teaching methods in school science courses despite the immense technical and social changes in the nation since that time Typical high school courses were considered to be woefully inadequate in addressing those many current problems which require scientific knowledge for their understanding—e.g energy, pollution, population resources, genetic engineering—and in providing students with the background knowledge and problem-solving skills they will need in their lives. It was noted that other countries are several years ahead of us in perceiving and reacting to what is, for them, a comparable gap

The conferees were unanimous in their conviction that no other high school discipline but science was appropriate or likely to address the societal and ethical consequences of modern science and technology

In the 1960's the method used by the N S F to update and upgrade science curricula was to support the creation of entirely new courses and to support a nationwide series of teacher training institutes It was an effort which, while very effective, was also very expensive and of limited duration in time The present need to update science curricula in a constantly changing society and an inflated and hard-pressed economy seems to require a method that can be sustained over an indefinitely long period of time

The conferees agreed that completely new courses should *not* be created, but rather there should be an approximately 10% infusion of material of societal and ethi-

cal character into the present courses Efforts should be undertaken at once to begin writing such material in such a form as to permit teachers a wide range of inexpensive choices of what to fit in and where to fit it By and large the material would replace rather than be added to present material in courses already crowded

The conferees also agreed unanimously that the most appropriate institutional response is the formation of a national network of permanent Science Resource Centers, each one responsive to local control and local teaching needs, yet linked by computer to the others Charged with the tasks of creating and distributing teaching materials addressed to societal issues (originating either locally or nationally) that require scientific knowledge for their understanding, and charged with the manufacture and distribution of low-cost apparatus on a large scale to local school systems, and with the task of providing teacher support services of many kinds, a system of Science Resource Centers has the capacity to continuously upgrade present conventional courses and to "recharge" the entire present science teacher community

Problems untouched concern the direction and staffing of the centers, which somehow must be balanced between national and local control for greatest effectiveness, and likewise the matter of financing

The urgency of launching at once into a carefully planned program, national in scope and addressed to the effects of science and technology upon American—and world—society, cannot be overemphasized

The Background

The Exeter Conference was conceived almost two years ago, partly as an effort to mark the Academy's 200th birthday but mostly because of our perception of the changing circumstances in which we find ourselves teaching science. There have been no major changes in the teaching of secondary school science since the curricular reforms of the 1960's, and consequently we are still living on the proceeds of those reforms

But circumstances have changed dramatically since those early post-Sputnik days. Problems that did not exist then have become pressing today, and old problems have changed their complexion entirely. Nuclear power and its social implications, declining student interest in science, pollution of the environment, the energy crisis, declining student achievement scores, even the relevance of the rational approach to problems are all perceived in new ways since the last science curriculum reforms took place. But more important, the public's attitude toward science has shifted significantly during the past few decades, we have moved from an era of public confidence to one of suspicion, even antagonism

Changes in society's perception of science are cause for serious national concern, urgent not only because of the scale of the problems but also because of the fact that school science enrollments, already low, are in steady decline As Paul DeHart Hurd put it in his opening address to the conference:

> About 1970 a series of social and economic events occurred in the United States which Kenneth Boulding, recent president of the American Association for the Advancement of Science, has summarized as a "cultural mutation." Young people sought a new meaning to life by exploring a wide range of pseudo-sciences and consulting mystics New family life styles emerged Those of you who teach in high schools can expect that one out of every eight students in your classes this fall comes from a single-parent home Young people also marched and fought for the betterment of the national environment—a movement that has broadened into an awareness about the quality of life The young adolescent and

> those over 65 years of age emerged as nonpersons without social or economic norms It took an energy crisis to make all of us aware that the problems of life and living today are world problems. Human survival includes new elements of risk These and a thousand other changes in human existence give meaning to Boulding's notion of a "cultural mutation "[1]

Boulding's "cultural mutation" applies to the changing attitudes of the young whom we teach. It also applies to the immense change in the cultural context of the science we teach them. Year after year science has become progressively less isolated from society until today we speak easily of this being the atomic age, the computer age, the space age, and even the petrochemical age. And to the degree that science becomes less and less isolated from society it is less and less value-free. Although J. J. Thomson's discovery of the electron was relatively independent of ethical values, it led ultimately to today's microcomputer industry, whose consequences are assuredly not. Thus science and more particularly technology undergo cultural mutations too and acquire societal and ethical attributes.

Conversely, the persistent problems of American life today—problems of health, depletion of natural resources, population control, nuclear proliferation, land use, energy—require a massive scientific input if solutions are to be reached.

Our traditional science courses, including the courses developed during the 1960's, rarely address these matters. At the time of their development the "cultural mutation" simply hadn't become so massively visible and threatening. Now that it has done so we look in vain for a response from the secondary school educational community. At the college level, courses in the social and ethical aspects of science are proliferating But the majority of America's

[1] Paul DeHart Hurd: "Science Education for the 1980's New Perspectives" An address delivered to the Exeter Conference, June 15, 1980

youngsters are not destined to take them, either because they do not go on to college or, in doing so, do not elect them. And at the high school level neither their science courses nor their social studies courses typically give these matters heed. If one accepts the proposition that social studies teachers do not consider themselves competent to address problems that have such a high component of technology then we must face the conclusion that unless the science teacher addresses the social and ethical aspects of science *no one else will*, and the majority of Americans will continue to base judgments that shape the future on intuition, short-term self interest, and political expediency

The problem this raises for the high school science teacher is massive, demanding, and urgent

Hence our conference.

THE CONFERENCE

It was the conference planners' belief that thirty-five to forty of the best science teachers from all over the country and a number of stimulating specialist consultants should be able to prod one another into defining the boundary conditions and priorities bearing on this problem as well as others that have emerged since the 1960's

The Esther A. and Joseph Klingenstein Fund and the Edward E. Ford Foundation generously agreed to provide funding

We began by trying to locate those special schools or teachers that had proven influential in the past and might therefore be active after the conference in promoting its goals We consulted admissions officers of key colleges and universities around the nation, the committee structures of the College Board and Educational Testing Service, the list of schools preeminent in producing National Merit Scholars, as well as individuals known to the committee members. Our invitations to schools and teachers thus identified met with gratifying acceptance and resulted in further nominations for us to consider. In the end there was no difficulty filling the forty places, a number dictated by our desire to house all the conferees in one dormitory so that maximum "after hours" exchange would be encouraged.

It was fortuitous that even as plans were well under way, one of the committee members (Compton) was invited to attend a week-long seminar on "Science, Education, and Society" held in Malvern, England, under the auspices of the International Council of Scientific Unions with fiscal support from UNESCO There it became clear that the Academy's concern was, indeed, a worldwide concern The Malvern Seminar therefore provided moral support for our decision to f[illegible] on the societal consequences of science at our c[illegible]e The seminar also.

provided some welcome hints on techniques for involving fifty conferees in useful and productive effort Unfortunately the discussions in Malvern also suggested that the United States is far behind much of the world in considering ways to educate people about the societal implications of science

Back in Exeter the planning committee determined quickly that it did not want to have the participants sit and listen to a succession of "experts" the participants were the experts The consultants should serve as a resource to encourage, to question, but only occasionally to provide answers.

It was decided to have a few consultants whose presence throughout the week would provide continuity and to have additional consultants come for a day or two, long enough to provide special input on single topics of concern and then to share in the ensuing discussions

The full-time consultants were Dr Paul DeHart Hurd, Professor of Education, emeritus, Stanford University, a key figure in the curriculum development programs of the '50's and '60's, John Lewis, Senior Science Master at Malvern College (a secondary school), Director of the Science and Society Project, England, and coordinator of the Malvern Seminar on "Science, Education, and Society"; and Dr Clifford Swartz, Professor of Physics, State University of New York, Stony Brook, Editor of *The Physics Teacher*, an author and experienced teacher at all levels from elementary to adult education

A full list of the teachers and the consultants and their affiliations appears in Appendix A

When the conference began the teachers and week-long resident consultants were divided into four autonomous discussion groups, each group charged with the same task Summarize your views of the problems as you see them in the *national* scene, and suggest workable programs of action Each individual participant was encouraged also to produce a program of action for his own school or department

The working day included lectures and panel discussions before the entire group by the consultants and round-table discussion-writing sessions in each of the four group meeting rooms. Visiting consultants (and to a smaller extent our resident consultants) moved from group to group contributing their expertise, challenging, and questioning At the end of the week four group reports and one personal report had been completed and printed. Their substance is summarized in the following sections

The Dimensions of the Problem

We had met, all fifty of us, because of unanimous agreement that there was a problem to be discussed. It is one that threatens the welfare of the nation and can only grow worse if no one does anything about it And it was clear from the start that the people responsible for doing something about it are the nation's high school teachers As science teachers, then, the conferees looked with some alarm at the following phenomena.

A There is growing evidence that the United States is falling behind other nations in the areas of science, technology, and science education

B There is a decline in enrollment in science courses which is expected to result in an inadequate supply of scientists and engineers as well as an inadequate scientific literacy among the voting population [2]

C Lack of confidence in scientific solutions is leading to an increased reliance upon mysticism

D The disparity between the scientifically literate and the rest of the population is increasing in our society

E There is a decline, in real dollars, of financial support for research and innovation and for education in the sciences

F The use of "hands-on" activities in science instruction is growing ever more restricted by budgetary and other constraints

G The time allotted to science in the lower grades is diminishing

It was suggested that these developments might partially stem from the fact that science programs in the schools have paid inadequate attention to those special aspects of science that make it seem important to the citizen. *In short, the public may be telling us that what we are offering in the name of science education is not relevant to American society today*

The conferees agreed that what is required is an infusion into existing programs of materials that place the study of science into a societal context The material must give young people opportunities to experience, with guidance, the sifting and weighing of evidence derived not only from the science laboratory but also from the avenues of information that are routinely available to the public, such as the media and the local library Students must be confronted with problems which, unlike those raised in the usual science programs, do not lend themselves to simplistic, uniquely "correct," answers Real social issues give rise to a variety of possible solutions, each providing some benefit but only at some cost[2]

Every school science program—whatever the special dis-

[2] According to a National Science Foundation Survey (Weiss, I R , Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education N S F Report SE-78-72, Washington, D C , U S Government Printing Office, 1978) only one-third of the school districts in the United States require more than one year of science in grades 9-12 for graduation Three-fourths of American high school students take biology, usually in the tenth grade, a little less than one-third take chemistry, and only one-sixth take physics

cipline, already involves materials that relate to real societal issues Hence infusion of these issues is possible in any science program, but only at the expense of the deletion of some topics from an already too-crowded syllabus The conferees suggested that inclusion of perhaps 10% could be achieved by replacing present examples and problems with new ones that raise significant social implications Even so small a shift in course content should significantly increase student appreciation of what constitutes a "real" problem, how it might be analyzed, and what constitutes an acceptable solution

As the week went on the dimensions of the task for the nation, the science teacher, and the student became increasingly clear

For the nation the problem is that the schools are producing citizens whose science background is not adequate for making the kinds of choices demanded of them by the newly emerging host of technology-laden social problems There will probably always be too few voters who can tell sense from nonsense, the only public policy measure that can increase their numbers is an improvement in the quality of education

For the science teachers the problem is that however great the good will, the technical training, and the experience, they usually have limited access to the essential information on a useful, illustrative social issue in a form that is usable in a classroom setting And new issues are constantly arising (e g chemical waste disposal) and old ones changing their dimensions Of necessity the teacher sticks to the permanent and unchanging on the grounds that in at least one sense nothing is so new as Newton's Laws nor so old as the morning newspaper

For the students the problem is that while they are, at best, being taught fundamental principles of science and problem-solving skills, their problems usually lack the requirement that they make value judgments and exercise choices, nor does the scene of those problems extend to societal issues Thus, in physics they may master Newton's Laws and learn to apply them to problems in the banking of highway curves, but will not go on to appreciate the part those calculations play in improving highway safety Nor will students probably extend their knowledge of the chemistry of gasoline and its combustion to the part automobile exhausts play in air pollution and public health, and almost certainly not to a consideration of the choices and trade-offs that must be made in legislating clean-air ordinances and mandatory automobile exhaust pollution controls In short, students are not being trained in the skills required if they are to apply knowledge of science to societal issues—and these skills require a great deal of training

A Response to the Problem

Classroom teachers are not in a realistic position to find and to organize all the resource materials required to carry out the changes we suggest Nor is it easy to see how they can find time to keep abreast of the developments in their profession, such as new ways of adapting computer-assisted instruction, new insights into the way in which their students learn science, new techniques for producing low-cost apparatus in the face of tightening budgets, availability of tapes, films, slides, and lecturers from local industries or universities Conventionally these matters have been handled through professional meetings and journals, but these avenues reach only a small and now declining fraction of the profession

Therefore we propose a national network of Science Resource Centers, patterned partially after the national network of County Extension Offices, that will undertake projects, collect data, and distribute materials to the teachers of the region as needed The centers may provide short-term training programs, will serve as repositories of information and data, and will provide services as requested by schools, teachers, or students We see industry, and business as being an important part of both the operation and the support of the centers Materials developed within a local region to meet its own requirements will become part of the catalogue in the national center and made available by computer to any center elsewhere Thus the resource centers will bring together all available local and national resources to improve and maintain the quality of science education at all levels

Some of the characteristics of the centers might be as follows

A They will be equipped to receive, store, process, and rapidly distribute information in many forms

B They will prepare materials for class use This may be done by teachers in the field who submit material to the center or by members of the center's staff Materials might include

a) case studies which involve students in the interpretation of data and in decision making

b) up-to-date data on topics of continuing concern such as economics, statistics, and population data

c) printed material on science and society in the United States patterned after the British *Science in Society Project* (Reference Science in Society Project, Malvern College, Malvern, Worcestershire, U K, John Lewis, Director Also available after January 1, 1981, from Heineman Education Books, Exeter, N H 03833)

d) programs and apparatus similar to that developed by the National Science Foundation and modified for local use by the Fairfax County Science Materials Center (Reference "Fairfax County Public Schools, 5920 Summers Lane, Falls Church, Va 22041, Douglas Lapp, Director)

C They will routinely distribute inexpensive fliers outlining data, developments, resources, bibliographies, and other information of current interest

D They will provide instruction through workshops, evening or weekend courses, summer programs, or the use of visiting instructors from the region The centers should also serve as meeting grounds for the profession The Illinois State Physics Project might serve as a model for this aspect of the regional center's work

E They will serve as a clearing house to aid teachers who wish to share their technical expertise through association with industry, universities, local civic groups, etc Teachers need resources, but they are themselves a resource that communities can often utilize more effectively

F The staffs should consist of directors and assistants as determined by the schools and the needs of the region It is important that the assistants be teachers representing various grade levels and serving on a rotating basis

There are at least three existing systems which may serve as useful models

1 County Extension Service The science center network we propose is analogous to the county extension service network which responds to needs of the farm community

2 National medical network In this network developed by the medical profession, extensive use is made of closed circuit television, computer discs, etc , to disseminate both technical information and techniques

3 Hot line This network is the "Media Resource Service" of the Scientists' Institute for Public Information

Funding for the Science Resource Centers should be shared among federal, state, and local agencies since all will benefit from the service of the centers Private and corporate foundations as well as businesses and industrial groups should also be involved to ensure funding that will permit long-term commitments unaffected by the winds of political change

The Immediate Future

The students we teach in the 1980's will be effective and voting citizens in the 1990's and after 2000 when many of the crises we have alluded to will have already reached their denouement Therefore there is need for all possible haste But it will take time to carry out our recommendations, and in the meanwhile there are some things that can be done at once

Teachers need only show an interest and a willingness to raise societal issues occasionally in class for the first step of our proposal to be realized From time to time students should be involved in discussions that lead to a diversity of alternatives but not necessarily to a single "correct" answer. Topics can focus on whatever the teacher finds available and current use of farm land for housing or highway construction, chemical dumping, legal issues such as "sun rights" where high rise congestion and solar energy efforts conflict Local citizens might be brought into class to join in the discussions, perhaps to provide resource materials. Such inclusion of parents or local citizens extends the educational process beyond the limited range of the school classroom This important first step in our proposal can be undertaken by any teacher interested and willing to take it

School administrations are urged to support science teachers who embark upon new programs within the framework of existing science projects We do not seek a new, untried syllabus but only an updated one that parallels programs already being tried with success in other countries. Given the moral support of their administrators, teachers should not require significant additional resources beyond those already available.

Professional science teacher associations can provide important resources of many kinds, from lists of available materials and speakers to actual training sessions at regional meetings. The annual meetings could provide the forum for dissemination of ideas generated by the Exeter Conference as well as the opportunity for participants of the conference to meet with other interested teachers. Professional societies have the influence that individual teachers lack to enlist industry and business and university personnel in the changes we have proposed. Finally, it is possible that regional sections of the professional societies could serve in the interim as prototypes of the regional science resource centers

Foundations are in the enviable position of making it possible to provide working examples. The Exeter Conference itself serves to prove the point. But one group of forty teachers, however visionary, could not define or study the full range of needs and possibilities. The Exeter Conference has defined one critical need and made a few specific recommendations which deserve further study. Already participants in the Exeter Conference have developed interest in expanding our work through summer conferences to be held in the Midwest and on the West Coast. We urge foundations to consider funding this continuing effort.

Foundations might also consider the serious need for a few pioneering individuals to prepare materials for the new programs. These writers will need to be familiar with classroom teaching and thus will probably be school teachers on leave from their teaching duties.

Finally, it is possible that foundations might support a pilot "center" Minimally, such a center could consist of a few teachers located close together and on part-time leave who would collect materials, write units for classroom trial use, and even go into the field to visit classes Optimally, the pilot center could serve as a prototype for others to copy as resources become available on a wider national scale

24

Conclusion

The composition of the Exeter Conference, as we propose to call it, was unusual in at least two respects. The teachers were not only carefully selected for their ability and experience but also they represented all kinds of secondary schools (public, private, parochial, day, and boarding), all three major sciences, and a wide geographic distribution. We can therefore hope our collective bias, if any, represents the best of the profession. Secondly, the Exeter Conference was unusual in treating the ten consultants, all scholars of national stature, as fellow conferees.

As a result, our recommendations represent a cross section of professional opinion that may be unique in the breadth of its origin.

As science teachers we cannot ignore the national need for young people adequately prepared to enter the scientific professions, but there are needs which transcend those of the potential scientists in our schools, and the unanimous conclusion was that the science programs in general have failed to meet these broader needs. Consequently, we have proposed several specific changes in school science education along with detailed recommendations for their implementation. We urge all who are concerned with the status of science education to continue the efforts initiated at the Exeter Conference and to support and implement the proposals outlined in this report.

R.F.B. and C.A.C.
August, 1980

Appendix A

PARTICIPANTS

B, C, P = Biology, Chemistry, and Physics

Ms. Ouida Bailey
Dept. of Science (B)
Lincoln-Sudbury Regional
High School
Sudbury, Massachusetts

Ms. Delores Baker
Dept. of Science
Ward Melville High School
Setauket, New York

Ms. Lynda Beck
Dept. of Science (C)
Phillips Exeter Academy
Exeter, New Hampshire

Ms Janet G Benedict
Dept. of Science (B,C)
Nova High School
Fort Lauderdale, Florida

Mr. Arthur Budington
Chairman, Dept. of Science
(B)
Nichols School
Buffalo, New York

Mr. Gilbert Burnett,
Chairman
Dept of Science (P,C,B)
St. George's School
Newport, Rhode Island

Mr. Thomas E. Cone III
Chairman, Dept. of Biology
Phillips Academy
Andover, Massachusetts

Mr. Donald Dorn
Chairman, Dept. of Science
(P,C)
Byron Junior High School
Shaker Heights, Ohio

Dr Judith L Doyle
Dept of Science
Newton North High School
Newark, Ohio

Dr. Richard Duffy
Dept of Science (P)
Newton North High School
Newtonville, Massachusetts

Mr. Nicholas Evangelos
Dept. of Science (B)
The Brooks School
North Andover,
Massachusetts

Mr Mel Everly
Chairman, Dept. of Science
(B)
New Trier East High School
Winnetka, Illinois

Mr. Clifford J Gillespie
Dept. of Science (C)
St. Paul's School
Concord, New Hampshire

Ms Margaret R. Henley
Area E Center for Enriched
Studies
Los Angeles, California

Mr. Robert B. Horton
Dept. of Science (C,P)
Evanston High School
Evanston, Illinois

Ms. Allene Johnson
Dept. of Science
Summit High School
Summit, New Jersey

*Mr. Bruce Koloseike
Dept. of Science (C,P)
Hanover High School
Hanover, New Hampshire

Mr Anthony L. Komorf
Dept of Science (P)
Albany Academy
Albany, New York

Mrs. Dolores Z. Kubiak
Dept. of Science (C)
Taylor Alderdice High School
Pittsburgh, Pennsylvania

*Mr. Stephen B. Leslie
Dept. of Science (B)
St. George's School
Newport, Rhode Island

*Mrs. John D. Lewis
Dept. of Science (C)
Champlain Valley Union High School
Hinesburg, Vermont

*Dr. Doris Litman
Chairman, Dept. of Science (B)
Taylor Alderdice High School
Pittsburgh, Pennsylvania

Mr. Rodney F. Mansfield
Asst. Supt., School Administrator
Mcelwain Street
Merrimack, New Hampshire

Mr. David T. McNamara
Chairman, Dept. of Science (B,C)
Shaker Heights Senior High School
Shaker Heights, Ohio

Ms. Gail Moulds
Dept. of Science (C)
Shorecrest Preparatory School
St Petersburg, Florida

Mr. James A. Musich
Chairman, Dept. of Science (B)
New Trier West High School
Northfield, Illinois

Mr. Kenneth Nelson
Dept. of Science (C)
Thomas Jefferson High School
Denver, Colorado

Mr. Donald O'Quinn
Chairman, Dept. of Science
Highland Park High School
Dallas, Texas

Mr. David Parfitt
Director of Science
Brookline Public Schools
Brookline, Massachusetts

Mr. Robert Reeves
Chairman, Dept. of Science (C)
Deerfield Academy
Deerfield, Massachusetts

Mr. Raymond Reich
Dept. of Science
The Gunnery School
Washington, Connecticut

THE EXETER CONFERENCE

Dr. James Spalding
Dept. of Science (P)
Lawrenceville School
Lawrenceville, New Jersey

Dr Ronald Townsend
Director of Research & Evaluation
Evanston High School
Evanston, Illinois

Mr Harold Van Schaik
Chairman, Dept. of Science (P)
St. Mark's School
Dallas, Texas

Mrs. Robert Voelkel
Chairman, Dept. of Science (C)
Polytechnic School
Pasadena, California

Dr. Sally Vonderbrink
Chairman, Dept. of Science (C)
St. Xavier High School
Cincinnati, Ohio

Ms. Marcella C. Waln
Dept. of Science (C)
George Washington High School
Denver, Colorado

Dr. Floyd Wilcox
Career Center (C,P)
Winston-Salem, North Carolina

* = Group Leader

CONSULTANTS

Paul DeHart Hurd, professor emeritus of education, Stanford University One of the architects of the NSF-supported reforms of the 1960's whose interests today include the history and reformulation of science education in the United States and science curriculum reconstruction in the Peoples' Republic of China

Edward Kormondy, provost, University of Maine (Portland), professor of biology, textbook writer, and actively concerned with ethical and societal issues arising from science.

Douglas Lapp, director of the Science Materials Center, Fairfax County Schools, Va., and active in several national panels and commissions.

John Lewis, senior science master, Malvern College (a secondary school), England, and one of the designers of the English science teaching reforms recently supported by the Nuffield Foundation. Presently director of the Science and Society Project

Margaret MacVicar, associate professor of physical science and professor of education, M I T , recently on Clark Kerr's Carnegie Council on Policy Studies in Higher Education

Mary Budd Rowe, professor of education, University of Florida, presently on leave at the National Science Foundation as director of the Research in Science Education program She has taught all the major sciences both in this country and abroad and served as state consultant in science and mathematics for Colorado Her specialty is how children learn science

David Rose, professor of nuclear engineering, M I T , and coordinator of the 1979 World Council of Churches conference on "Faith, Science, and the Future" at M I T

Jonathan Smith, professor of history of religion and early Christian literature and Dean of the College, University of Chicago

Clifford Swartz, professor of physics, State University of New York, editor of the monthly journal *The Physics Teacher*, and author of physics texts at all levels

Robert Tinker, Technical Education Research Center, Cambridge, Mass , whose concern is the use of computers in education

Appendix B

Examples of societal issues appropriate to this program include

Chemical additives to food, plants, and soil

Mount St. Helens—and other recurrent natural phenomena

Science of sports

Genetic engineering—recombinant DNA

Examples of technological change
The industrial revolution
Electronic miniaturization

Air pollution (sample outline below)

Alternative energy sources

Chemical wastes: gas, liquid, and solid (For example, pollution controls on automobiles, outline following)

Simple conservation measures—effectiveness and costs

Pseudo-science—Bermuda triangle, UFO's, astrology

Population (sample outline below)

Appendix C

Three sample outlines

AIR POLLUTION

This is an example of a topic to be used in chemistry It could be used several times during the year accompanying the study of various sections of the present chemistry curriculum. Because data and information could be presented in problems and as applications of fundamental principles, such an infusion need not be artificial or forced

A. Learning skills to be developed would include
   - Chemical calculations
   - Library research
   - Laboratory procedures
   - Analysis and interpretation of data

B Societal concerns to be explored are the effects of air pollution on
   - Economics
   - Health
   - Food supply
   - Energy utilization

C. Human resources available in support of teaching
   - Representatives from government agencies involving health and agriculture
   - Local physicians
   - University personnel
   - Specialists from industry

D Examples of classroom activities to be developed in the Science Resource Center
   - Presentation of current and historical materials on the types and causes of air pollutants
   - Exposition of the relationships between pollution-causing processes and consumer goals
   - Films, film strips, TV discs, and transparencies
   - Teacher demonstrations and student experiments

AUTOMOBILE POLLUTION CONTROLS

If source material is available this topic is appropriate to courses in chemistry, environmental science, biology, physical science, mechanics, and industrial arts

A Learning skills to be developed would include
- Chemical calculations
- Library research
- Laboratory procedures
- Analysis and interpretation of data

B Societal concerns to be explored are
- Cost of automobile pollution control
  - a) to industry and to the available supply of necessary raw materials
  - b) to the automobile owner in cost of the car and cost per mile of operation
- The effect upon health of the pollutants in uncontrolled exhaust gases
- An analysis of air near a busy highway for pollutants

C Examples of materials to be developed in the Science Resource Center
- Diagram of engine and exhaust train of an automobile
- Description of purpose and operation of control devices
- List of state and federal emission control standards
- Information on known pollutants
- The chemistry and physics of the pollution control process
- Standards for safe air
- List of representatives from local industry, government agencies, and universities who are able and willing to speak
- Current literature, films, tapes, and transparencies

POPULATION

If source material is available, societal issues such as the following may easily be integrated into existing science courses When the student has achieved an understanding of sound biological principles, the societal issues will then be dealt with in a way that enables the students to discover contrasting ideas and values, and they can be pressed to make their own decisions

A Conventional biological concepts will include human reproductive anatomy and physiology
- The menstrual cycle
- Feedback mechanisms (hormones)
- Fertilization, embyrology, and prenatal care
- Birth
- Birth control

B The population concepts will include
- Use of population statistics
- The effects of age distribution on population growth rates
- Case studies dealing with overpopulation of some developing countries
  - Starvation and other nutritional effects
  - Environmental and climatological influences
  - Cultural reproductive traditions
- Effects of overpopulation
  - Shortages of energy, food, shelter, medical care
  - Effects of overpopulation on the environment

C Examples of materials to be developed in the Science Resource Center
- Specially written study units
- Current magazines and pamphlets
- Materials from lobbying groups such as "Right to Life" and "Zero Population Growth"
- Films, tapes of interviews, transparencies, etc
- Doctors, economists, nutritionists, religious leaders, industry representatives in the local area who are knowledgeable, able and willing to speak, and ideally have contrasting views

Appendix D

SUMMARY OF RECOMMENDATIONS

In summary the group reports all agreed, or were consistent with, two general recommendations which we offer here as the essence of our conclusions

a) Societal issues must be raised *as an integral part of* the present courses in chemistry, physics, biology, general science, and earth science, not as separate courses. Conferees were well aware that if material is added to a course, already crowded, that something must be dropped. An infusion of perhaps 10% seemed appropriate and feasible, some of which could be achieved by using societal topics in place of present examples to illustrate principles being taught

b) A nation-wide network of regional science resource centers should be established on a permanent basis to develop and distribute low-cost apparatus and constantly up-dated materials and to provide advice and resources of all sorts to regional science teachers