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ABSTRACT

The document provides guidelines intended for: (1) the preparation of secondary level chemistry teachers; (2) the publication of texts; (3) sponsorship of workshops, summer conferences, and institutes; and (4) the continuing education of teachers. The guidelines emphasize: pre-service preparation; necessity of continuing education; laboratory-centered secondary programs; and the responsibilities of secondary chemistry teachers, teacher educators, state and national agencies, and industry. (SL)

Guidelines and Recommendations for the Preparation and Continuing Education of Secondary School Teachers of Chemistry

Presented to the
Educational and Scientific Communities
by the American Chemical Society

While reading a textbook of chemistry, I came upon the statement, "nitric acid acts upon copper" . . . and I determined to see what this meant . . . Having located some nitric acid, . . . I had only to learn what the words "act upon" meant . . . In the interest of knowledge I was even willing to sacrifice one of the few copper cents then in my possession. I put one of them on the table; opened the bottle marked "nitric acid"; poured some of the liquid on the copper; and prepared to make an observation. But what was this wonderful thing which I beheld? The cent was already changed, and it was no small change either. A greenish blue liquid foamed and fumed over the cent and over the table. The air . . . became colored dark red . . . How should I stop this? I tried . . . by picking the cent up and throwing it out the window . . . I learned another fact; nitric acid . . . acts upon fingers. The pain led to another unpremeditated experiment. I drew my fingers across my trousers and discovered nitric acid acts upon trousers . . . That was the most impressive experiment . . . I have ever performed. I tell of it even now with interest. It was a revelation to me. Plainly the only way to learn about such remarkable kinds of action is to see the results, to experiment, to work in a laboratory.

Ira Remsen (1846-1927)
Distinguished American Chemist
President, Johns Hopkins University

When we shall be able to employ in scientific education, not only the trained attention of the student, and his familiarity with symbols, but the keenness of his eye, the quickness of his ear, the delicacy of his touch, and the adroitness of his fingers, we shall not only interest . . . people who are not fond of cold abstractions, but, by opening at once all the gateways of knowledge, we shall ensure the association of the doctrines of science with those elementary sensations which form the obscure background of all our conscious thoughts, and which lend a vividness and relief to ideas, which, when presented as mere abstract terms, are apt to fade entirely from the memory.

James Clerk Maxwell (1831-1879)
Distinguished British Mathematical Physicist; developer of modern electromagnetic theory and kinetic molecular theory

The principal goal of education is to create men and women who are capable of doing new things, not simply of repeating what other generations have done . . . who are discoverers. We need pupils who are active, who learn early to find out by themselves, partly by their own spontaneous activity and partly through the materials we set up for them.

Jean Piaget (1896-)
Contemporary Swiss
Educational Psychologist

Guidelines and Recommendations for the Preparation and Continuing Education of Secondary School Teachers of Chemistry

Table of Contents

The basic recommended Guidelines for the preparation and continuing education of secondary school teachers of chemistry are given on pages 4 and 5 and are followed by recommendations for mechanisms of implementation to various individuals, organizations, and agencies which exert a direct influence on secondary school education in chemistry

American Chemical Society
1155 Sixteenth Street, N W
Washington, D C 20036
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Introduction

A comprehension of chemistry is necessary for a full understanding of many fields of knowledge and for responsible decision-making in numerous areas of public concern.

The secondary school chemistry teacher plays a pivotal role in the public's understanding of chemistry, transcending that of any other agent or group. For most citizens, high school chemistry is the first and only opportunity for systematic exposure to the science

Consequently, the teaching of chemistry to secondary school students is an awesome responsibility. Not only must the teacher be proficient in the art and science of teaching, but he or she must also possess the knowledge and ability to communicate selected details of chemistry with both simplicity and accuracy. Further, given the nature of the task, the teacher must strive assiduously to keep up-to-date with the developments of chemistry itself and with the means of teaching them to the students.

Many organizations and individuals are involved in the improvement of secondary school chemistry teaching. These guidelines are intended to assist them in (for example) the preparation of teachers, publication of texts, sponsorship of workshops, summer conferences and institutes, and in the continuing education of teachers. In this spirit,

these Guidelines emphasize:

- the importance of appropriate pre-service preparation for secondary school teachers of chemistry
- the necessity of continuing education for secondary school chemistry teachers
- the role of laboratory-centered programs in secondary school chemistry instruction
- the instructional and curricular implications of such programs in the preparation of secondary school chemistry teachers

and the responsibilities of

- secondary school chemistry teachers
- teachers of secondary school chemistry teachers
- local, state, and national agencies, organizations, and individuals
- chemical and other industries

in their mutual concern for the quality of instruction in chemistry in the secondary schools.

The Laboratory

Laboratory work is an indispensable part of chemistry instruction. In the hands of a good teacher it is in itself an excellent vehicle for instruction.

- It gives an insight into authentic science.
- It is intellectually exacting. It requires careful attention to planning, execution, and observation. It demands interpretation and abstraction.
- Most students enjoy it. It couples cognitive activities with "hands-on," action-oriented, concrete operational activities. It is a stimulating change from lectures and other forms of instruction.
- It is interdisciplinary. It sharpens students' skills in:
  - Reading and writing;
  - Applying mathematics to real problems;
  - Classifying, measuring, interpolating, extrapolating, drawing inferences, framing hypotheses, and building mathematical, verbal, and physical models.
- It helps students to develop manual dexterity, patience, dependability, and a spirit of cooperation.
- It helps to enhance and strengthen student-student and student-teacher interpersonal relations.

A learning laboratory is a busy laboratory. Although it is time-consuming for students, and mentally, emotionally, and physically taxing for teachers, laboratory work is indispensable—if the spirit of science is to be conveyed to the younger generation and if they are to develop the capacity for independent learning

This is the lesson of the laboratory method, and the lesson which all education has to learn: The laboratory is a discovery of the conditions under which labor may become intellectually fruitful and not merely externally productive.

John Dewey (1859–1952)
Educator and philosopher

GUIDELINES
SECONDARY

To manage a chemistry program which has a laboratory emphasis with confidence, enthusiasm, efficiency, and safety, to be able to pose and to answer questions, and to acquire a base for continued professional growth, it is recommended that a prospective secondary school chemistry teacher should have at least the formal college-level academic preparation outlined below.

In addition to the science and professional requirements listed above, the prospective teacher is expected to complete the normal course requirements in the humanities and social sciences, plus appropriate courses in mathematics which are co- and pre-requisite to chemistry and other science courses

Inclusion of interdisciplinary curricula in teacher preparation programs is encouraged

Semester hours are cited because they are the major medium of academic exchange The acquisition of chemical knowledge and professional teaching skills by recognized means other than formal courses is not excluded

FOR

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The importance of continuing education for chemistry teachers cannot be over-emphasized

1 All teachers are urged to continue their professional development; other persons and agencies, who, by their assignments and function, are also responsible for continued improvement in the delivery of instruction, are urged to assist in providing continuing education opportunities for secondary school chemistry teachers

2. Chemistry teachers who do not have the recommended pre-service credentials as part of their training should seek opportunities to continue their education to achieve these credentials as soon as possible.

3 Because of the rapid increase in chemical knowledge and its application, it is necessary that even those teachers who meet the pre-service requirements outlined in this document pursue further education

4 Specific recommendations which apply both to teachers who do and who do not initially meet the pre-service requirements are given below

Recommendations to Agencies and Individuals

In the following sections, actions to implement and support pre-service and continuing education programs in chemistry are specified for:

- Chemistry teachers
- College and university teachers, primarily in chemistry and education
- State and regional education officials
- Local school boards, superintendents, principals, science supervisors, curriculum specialists, department heads
- State and local groups, such as science academies, parent-teacher-student associations, ACS local sections, industries, museums
- ACS and other national scientific organizations and funding agencies
- Professional teacher organizations

Recommendations to the Teacher

"I find chemistry much easier to understand when it is related to everyday things or explained using examples of common items we all see and work with"[I]

Teachers should

1 Recognize that growth in teaching is an on-going endeavor. They should avail themselves of opportunities for growth, especially in interdisciplinary areas such as environmental chemistry, biochemistry, earth science, chemical instrumentation, and career/vocational education. They should participate in appropriate college courses, ACS and other short courses, self-study programs, in-service programs, professional meetings, and inter-class and inter-school visits with science teacher colleagues. Other opportunities for professional service and growth include cooperation in providing field opportunities for chemistry teachers-in-training, summer employment in the chemical industry, developing and testing new laboratory experiments, designing and participating in chemical research projects, remedial work with college chemistry students.

2 Keep abreast of current developments in chemistry with periodicals and journals such as:[II]

† *Chemistry*
† *CHEM 13 NEWS*
† *Journal of Chemical Education*
Chemical & Engineering News
CHEMTECH
Environment
Science
† *The Science Teacher*
Science News
Journal of College Science Teaching
Scientific American
The American Biology Teacher
The Physics Teacher

3 Employ self assessment instruments (such as those published by the National Science Teachers Association) and plan specific programs for continued professional growth.[II]

4 Investigate alternative teaching strategies and programs. They should examine, for example, information on new teaching programs and formats available in exhibitions at national and local education and science meetings, as well as in relevant journals.

5. Work directly with school librarians to maintain a well-organized, current chemistry library with a complement of films and multi-media materials as well as periodicals and journals, all to supplement the student's textual materials and to provide an adequate reference library for the science faculty. [See "Selected Titles in Chemistry," 4th ed. (1976), American Chemical Society, "Science Books and Films," (published quarterly) American Association for the Advancement of Science; "The AAAS Science Book List," (published at intervals).]

6 Interact with mathematics, English, and social studies teachers as well as associated science faculty in curriculum development and innovation.

7 Submit comments, letters, or articles on teaching strategies and ideas to

† Especially suitable
[I]These, and other comments in the margins, are, except where noted, taken from letters to the Writing Committee from secondary school chemistry students
[II] See appendix for addresses and other details

5 newsletters such as *Chem 13 News* and other professional publications such as *The Science Teacher* and the *Journal of Chemical Education*

8 Take students to local science meetings.

9. Interact with nearby college or university faculty members and with chemists in local industries, hospitals, museums, police departments, and government agencies to exchange viewpoints and to arrange personal or class visits to their laboratories. (Often, this can be arranged through a local ACS section.)

10 Become a member of at least one national scientific-educational association and participate in the activities of that group.

11 Participate in community programs that involve chemistry (e.g., pollution, energy crisis, scouting, geriatrics, drug use and abuse, etc.).

12 Make known to administrators suggestions regarding facilities which are needed for effective teaching.

13 Make known to colleges and universities of their choice the type of courses they need for continuing education.

14 Relate the above actions to the teaching program, set personal goals for the achievement of some of the foregoing, and review these annually in consultation with immediate supervisors.

Recommendations to College and University Faculties

Although this section is addressed to faculties of educational institutions in general, it is ordinarily the chemistry and the science education faculties that are specifically charged with the education of chemistry teachers. Clearly, for this charge to be carried out effectively, the faculties of these departments must cooperate in the development and in the conduct of both new and existing educational programs. Neither group should view any of the following recommendations as applying solely to the other; the intent is to encourage cooperative planning and the assumption of joint responsibility.

For Pre-Service Education

1 Provide methods courses for chemistry teachers which include an emphasis on laboratory.

a. Emphasize actual, hands-on laboratory experiences.

b. Simulate high school "prelab-lab-postlab" periods based on experiments drawn from different laboratory-centered programs, with role-playing by participants.

c Consult with and employ practicing secondary school chemistry teachers as observers or as part of instructional teams in order to keep methods courses in close touch with classroom realities and needs.

d Discuss and demonstrate

- How to teach laboratory skills
- How to locate and to develop experiments suitable for short laboratory periods.*
- Laboratory management, particularly
  - safety, including the safe use of chemicals
  - strategies for teaching laboratory logistics
  - ordering materials
  - waste disposal.

"A good chemistry teacher is one who makes his class interesting; performs demonstrations to illustrate what he teaches and one who understands students."

2 Evaluate the presentation of chemistry in college-university lectures, laboratories, and in resource room learning centers. New teachers often tend to teach in the styles by which they were taught, and steps should be taken to improve the techniques and the image since these are likely to be imitated by the new teacher.

"I feel the most important aspect of a teacher's knowledge is his ability to field questions from baffled students and answer these questions in a simple and understanding way."

3. Include in teacher preparation programs early and continued student exposure to actual classroom teaching experiences. Structured observations of both junior and senior high school science classes in a variety of settings (urban, rural, suburban) should be an early part (in the freshman year when possible) of each pre-service chemistry teacher's program. For early, low-risk teaching experiences, prospective teachers should be considered for involvement in the tutoring of individual high school students. A growing career commitment to teaching, or a considered decision not to enter the teaching field, can thus be identified relatively early in each student's undergraduate program.

* Such as some of those in the Lab Bench section of *Chemistry*, or in selections therefrom in the manual "*Lab Bench Experiments in Chemistry*," American Chemical Society, 1155 16th St., N.W., Washington, D.C. 20036, and in Alyea, H. N. and F. B. Dutton, *Tested Demonstrations in Chemistry*, 6th ed., *Journal of Chemical Education*, Publication Office, 238 Kent Road, Springfield, PA 19064.

Such activities also build an important feeling of professionalism and camaraderie among prospective science teachers, and provide a motivational base for subsequent professional training courses.

"Before chemistry teachers begin their practice, they should spend a great deal of time with all students in general, in order to achieve a type of communication and friendly relationship."

4 Provide additional teaching experiences for the pre-service teacher through activities such as peer teaching and counseling (senior teaching majors with first year education students, for example), internships, assisting or tutoring in the university's introductory chemistry courses, as well as the conventional supervised student teaching. Expanding the pre-service teacher's opportunities for a range of teaching experiences implies that teaching is an excellent (perhaps the best) way to learn. hence, such activities are worthy of academic credit towards the totals recommended earlier in these guidelines.

5 Include in the chemistry content program for teachers some independent study experiences to impart the flavor of scientific investigation in a realistic way (e g , de-bugging lecture demonstrations, de-bugging laboratory experiments from high school courses or introductory courses at other levels, developing and testing new experiments).

6 Illustrate by example that a variety of teaching strategies and techniques can be effective in helping students to learn chemistry

"I think that teachers should be requested to take a refresher course on all new information. They should know what they are talking about."

7 Assess practicing teacher needs with the assistance and cooperation of teachers, supervisors, principals, and professional groups; locate talent to meet the needs (e g , from experienced teachers, college staff, professionals from the community). i e , design flexible course schedules and materials to meet in-service teacher needs Courses in current science/chemistry concerns (energy, environment, drugs, etc) which emphasize utilization of available techniques applied to the solution of societal problems, and the presentation of these to young students using a laboratory-centered approach, will serve as examples here

8 Share college and university faculty and facilities with area secondary school chemistry teachers

a. Arrange special evening sessions for secondary school teachers when seminar speakers, consultants, and other visiting scientists and educators are on campus

b Sponsor on-campus professional days for chemistry teachers and supervisors to discuss common concerns and problems, and to familiarize them with resources, library facilities, and other materials and expertise available for their continued use.

9. Offer broadly-based graduate degree programs in chemistry or chemical education for high school teachers. These graduate students need, and can use for their own students, courses in areas such as geochemistry, information retrieval, biochemistry, oceanography, forensic chemistry, the history of chemistry, and a capstone course that surveys high school chemistry from an advanced standpoint and which includes problem solving.

Recommendations to State and Regional Education Officials

1. Organize workshops and summer laboratory programs that bring together faculties from high schools and colleges. Possible topics could include introduction to new curricula, development of instructional materials, updating in chemistry

2 Sponsor a state-level science education development center to provide resources and services, as well as a place where teachers may see examples of innovative developments and where they can participate cooperatively in educational planning

3 Establish a source of funds used for implementing teacher efforts and opportunities to improve their courses and to develop professionally

4. Distribute copies of these guidelines to teachers They may be obtained from the Department of Educational Activities, American Chemical Society, 1155 16th Street, N.W , Washington; D.C. 20036

5 Assume leadership in the continuous evaluation of policies that reflect reasoned acceptance or modification of the objectives of these and similar guidelines

Recommendations to Local Officials

1 Facilitate laboratory-centered instruction

a Respond to the teachers' identified needs for expendable supplies and equipment maintenance.

b Determine maximum class sizes which are consistent with safety and which are suitable for laboratory-oriented learning

c. Provide preparation time for the special demands of laboratory-centered instruction
d. Utilize para-professionals to assist in the implementation of laboratory-centered programs
e. Provide resource and reference materials. Schools or department libraries should have subscriptions to *Chemistry, Journal of Chemical Education, The Science Teacher*, and selected additional journals, such as *Chemical and Engineering News, The American Biology Teacher, The Physics Teacher, Scientific American, Journal of College Science Teaching*, and *Science News*,[I] for reference use by students and teachers. Texts for reference use should be available to support the teacher in areas such as general chemistry, organic, inorganic, biochemistry, environmental chemistry, analytical, and physical chemistry.

2. Facilitate the continuing education of chemistry teachers.
   a. Develop plans with teachers, early in their careers, for continuing education and professional growth, subject to annual review and modification. The NSTA publishes materials which will provide some assistance in such planning.[II]
   b. Arrange schedules to allow time for novice teachers to work cooperatively with teachers experienced in laboratory-centered instruction and to attend appropriate scientific and educational meetings and conferences.
   c. Encourage and support frequent inter-class and inter-school visits among chemistry teachers.
   d. Sponsor workshops that bring together teachers from high schools, college chemistry departments, and schools of education.
   e. Provide sabbatical or shorter opportunity leaves, provide tuition assistance, and otherwise support financially the continuing education of teachers.
   f. Recognize and reward teachers for achievement in meeting the recommendations of these guidelines.
3. Support teacher participation in the activities of science teacher groups, academies of science, and other professional organizations.
4. Insure that copies of these guidelines are distributed to chemistry teachers.

Recommendations to State and Local Agencies, Organizations, and Industries

(e.g., American Chemical Society and American Institute of Chemists local sections, state academies of science, local industries, parent-teacher-student associations, museums)

1. Arrange special topic seminars on local or national issues of current interest presented by teacher-student teams.
2. Sponsor incentive awards for students and teachers, such as short course tuition fees, mini-grants, books.
3. Provide financial support for local science teachers' (secondary school, two-year college, college and university) meetings and workshops on topics addressed to the felt needs of the participants.
4. Provide speakers bureau services to secondary school classes and teacher groups.
5. Distribute surplus and expendable supplies and equipment from industries and other sources to secondary schools, and provide for their maintenance.

A blunt tool, grown dull from long disuse, is costly to its owner. Ecclesiastes 10:10

Recommendations to National Organizations and Agencies Concerned with Chemical Education

(such as AAAS, ACS, ABTS, AIC, MCA, NAIEC, NASA, NCEA, NIE, NSF, NSSA, NSTA, USOE[III])

1. Assist teachers with the logistics of secondary school laboratory management; safe handling of reagents, and waste disposal; prepare and publish a "Laboratory Management and Safety Handbook."
2. Help to meet the continuing education needs of secondary school teachers, develop and deliver teacher training projects and activities such as content-oriented workshops, and traditional, multi-media, or other innovative self-study programs, with the cooperation of academic institutions.

"I think that when it comes to teaching a course as hard as chemistry, the teacher ought to have a good background of material and a good knowledge of just about everything."

[I] See appendix for addresses.
[II] See appendix for details.
[III] American Association for the Advancement of Science, American Chemical Society, Association for the Education of Teachers in Science, American Institute of Chemists, Manufacturing Chemists Association, National Association for Industry-Education Cooperation, National Aeronautics and Space Administration, National Catholic Education Association, National Institute of Education, National Science Foundation, National Science Supervisors Association, National Science Teachers Association, United States Office of Education, and others.

"Our teacher is a very fine one and I believe he should have the chance to further his education in the field of chemistry. I am very sure this could benefit everyone."

8 Publish descriptions of experiments (or demonstrations) suitable for 50 minute "prelab-lab-postlab" periods.

4 Publish guidelines to aid in the effective use of para-professionals and student assistants in chemistry teaching.

5 Organize a clearinghouse to assist and encourage industrial summer or sabbatical leave employment of prospective and current chemistry teachers

6 Establish Chautauqua-type short course programs for secondary school chemistry teachers

7. Maintain a roster of professional personnel, including retired teachers and chemists, to serve as consultants, reviewers, and resource persons

8. Encourage the evaluation of performance-based teacher education strategies

9 Provide programs designed to meet the needs and interests of secondary school chemistry teachers at national, regional, and local meetings and conferences.

10 Provide programs and funding for research directed toward the improvement of chemistry teaching.

Recommendations to Professional Teacher Organizations

(such as AFT, NAPE, NEA*)

Obsolescence of teachers as professionals is a common concern to both scientific and professional organizations. The support of professional organizations is solicited in promoting the continuing professional development of teachers by:

- Supporting the recommendations made elsewhere in these guidelines.
- Assisting their members to meet the standards set in these and similar guidelines.
- Further implementation of continuing education programs for their members.

Other Issues

During the development of these guidelines the Writing Committee, in its concern for student learning, questioned but generated no recommendations regarding the desirability of:

Teaching of secondary school chemistry as a preparation for college chemistry *vs.* emphasizing the role of chemistry as a part of the general education of students.

Criteria used to identify excellence in teaching of chemistry—such as those based on teaching sophisticated content, as such, *vs.* teaching the relationships of chemistry to students' present and future daily lives.

Formal position papers as well as informal letters on these issues and other topics in these guidelines are welcome and should be sent to the Department of Educational Activities of the American Chemical Society

* American Federation of Teachers, National Association of Professional Educators, National Education Association

APPENDIX I

History of these Guidelines

In 1971 the Educational Policy Sub-Committee of the Council Committee on Chemical Education, a standing committee of the Council of the American Chemical Society, was charged to draw up a set of recommendations which related to educational policy and to which the parent committee might be able to address itself with some effect

The Educational Policy Sub-Committee (composed of Stanley Kirschner, Chairman, John C. Bailar, Jr., and W T Lippincott) met in Chicago, Illinois, on June 10, 1971, and prepared a set of recommendations for the consideration of the Council Committee on Chemical Education Recommendation number 4 of that report reads in part, as follows

> "The Educational Policy Sub-Committee recommends to the parent Council Committee on Chemical Education that it study the problem of assessing and influencing minimum standards in chemistry instruction at secondary and junior high schools throughout the United States. In particular, it should study the minimum standards of education in chemistry."

The parent committee, through its Sub-Committee on Pre-College education, gave attention to this question, and in 1974, the American Chemical Society Council Committee on Chemical Education proposed to the Council and Board of Directors of the Society that a set of guidelines for the preparation and continuing education of secondary school chemistry teachers be prepared and widely distributed The Council and Board approved and, in September 1974, the Board allocated funds to support the project In April 1975, the Committee on Chemical Education appointed a task force Steering Committee

The Steering Committee convened in August 1975. Writing and Editorial Committees were identified and charged with preparing for review a set of guidelines that would be:

- perceived as practical,
- specific without being restrictive;
- addressed to both pre- and in-service needs of teachers and to faculties in both education and chemistry, and
- attentive to the cooperation and assistance of other groups who share responsibility for improving secondary education in chemistry

In December 1975, the Writing Committee met in Reston, Virginia It prepared a set of statements from which the Editorial Committee wrote a preliminary draft of these guidelines The draft was reviewed by the Writing Committee in January 1976

The resulting "first draft" was then reviewed by representatives of various groups concerned, both directly and indirectly, with the teaching of secondary school chemistry—from secondary school students to teachers of teachers and supervisors, as well as local school boards and the teachers themselves Following these reviews and further modifications of the document through additional drafting stages, and after the necessary internal approval procedures within the American Chemical Society, these guidelines were first published in 1977

APPENDIX II

Performance (competency) Based Teacher Education (PBTE)

In PBTE, pre-service teachers are expected to demonstrate ability to perform specific teaching-related activities The performance goals to be achieved are specified in rigorous detail in advance, and understood and accepted by the student. Ideally, the list of goals comprises all of the critical skills and behaviors which a teacher must possess in order to perform well as a teacher, without imposing time restrictions for their achievement

PBTE may be superior to traditional teacher education strategies. More likely, the two in concert may be particularly effective To the extent that PBTE goals have been formulated, their use in teacher education merits evaluation

A complete set of performance goals for secondary school chemistry teachers would include descriptions of a variety of motor skills, concepts and their application, and attitudes At a minimum, these would pertain to education, chemistry and related sciences, and mathematics, with some reference to the humanities and social sciences Clearly, a cooperative effort would be necessary to explore adequately the possible formulation of a complete set of such performance goals

Since experience with PBTE strategy is limited at the present time, these guidelines have specified the criteria for pre-service teacher preparation in traditional terms, pending further developments in the general acceptance and utilization of the PBTE strategy

"I personally felt that not only should the chemistry teacher be taught well in chemistry, but should also be instructed in human psychology, teaching methods, etc."

APPENDIX III

Publications

(*1976 subscription prices are listed)

(1) Selected Periodicals for Chemistry Teachers and Science Departments

The Americal Biology Teacher National Association of Biology Teachers 11250 Roger Bacon Drive Reston, VA 22090	$15.00/year (with NABT membership included) $18 00/year for institutions, $7 00/year for student members
Chemical and Engineering News American Chemical Society 1155 16th Street, N W Washington, DC 20036	Provided with ACS membership. $15 00/year or $32 00/3 years for non-members.
Chemistry American Chemical Society 1155 16th Street, N W Washington, DC 20036	$8 00/year; special group rates for 10 or more subscribers
CHEMTECH American Chemical Society 1155 16th Street, N W Washington, DC 20036	$9.00/year for ACS members, $18.00/year for nonmembers, $45 00/year for institutions, libraries, companies; $4.50/year for students
CHEM 13 NEWS Department of Chemistry University of Waterloo Waterloo, Ontario N2L 3G1	Optional contribution to help defray postal costs welcomed
Environment Circulation Department P O Box 755 Bridgeton, MO 63044	$12 75/year for individuals, $17 50/year for institutions, $10 00/year for students
Journal of Chemical Education Circulation Service 119 W 24th Street—4th Floor New York, NY 10011	$10.00/year, published by ACS Division of Chemical Education
Journal of College Science Teaching National Science Teachers Association 1742 Connecticut Avenue, N W Washington, DC 20009	$18 00/year with college membership in the National Science Teachers Association, $25 00/year for schools or libraries
The Physics Teacher American Association of Physics Teachers Graduate Physics Building State University of New York Stony Brook, NY 11794	Non-AAPT members, $18 00/year; membership, including TPT as an option, $22 00/year.
Science American Association for the Advancement of Science 1515 Massachusetts Avenue, N W Washington, DC 20005	$25 00/year with individual membership in AAAS, $18 00/year for students, subscriber rates, $50 00/year

ience News bscription Department 1 West Center Street arion, OH 43302	$10 00/year, $18 00/2 years, $25.00/3 years
e Science Teacher tional Science Teachers Association 42 Connecticut Avenue, N.W ashington, DC 20009	$18 00/year with secondary school membership in the National Science Teachers Association; $25 00/year, school or library
ientific American bscription Manager 5 Madison Avenue ew York, NY 10017	$15.00/year, $27 00/2 years, $37 00/3 years

The NSTA Self-Assessment Materials*

Guidelines for Self-Assessment of Secondary-School Science Programs*
- I. Our School's Science Curriculum (#471-14672, $1 00 each).
- II. Our School's Science Teacher (#471-14674, $1 00 each)
- III. Science Student/Teacher Interactions in Our School (#471-14676, $1 00 each)
- IV Facilities and Conditions for Science Teaching in Our School (#471-14678, $1 00/each)

port Form, 2 copies (#471-14680, $1 00 each).

mplete Self-Assessment Package, including one copy of each of the four Modules, 2 Report Forms, and introductory preface (#471-14682, $5 00).

d $0.50 for handling and mailing Postage will be charged on billed orders

rder from National Science Teachers Association, 1742 Connecticut Avenue, N W , Washington, DC 20009

APPENDIX IV

Project Personnel

American Chemical Society Council Committee on Chemical Education, Members 1975-1976

James J. Hazdra (*Chairman*)
Illinois Benedictine College

Harold T. Baker
Lamar State College of Technology, Tex

John A. Beel
University of Northern Colorado

Donald J. Bettinger
Ohio Northern University

Allan Cairncross
E.I du Pont de Nemours & Co. Del

Newman H. Giragosian
Delphi Marketing Services, Inc, N Y

Sister Agnes Ann Green
Immaculate Heart College, Calif

Edward S. Hanrahan
Marshall University, W.Va.

Edward H. House (1975)
Mercer County Community College, N J

Lester Kieft
Bucknell University, Pa

Stanley Kirschner (*Chairman, 1975*)
Wayne State University, Michigan

Albertine Krohn (1975)
University of Toledo, Ohio

John J. Lucier
University of Dayton, Ohio

Kathryn P. McHugh
Amundsen High School, Chicago

Albert W. Meyer (1975)
Industrial Chemical Consultant, N J

Therald Moeller
Arizona State University

William A. Nevill
Indiana University—Purdue University

Olaf A. Runquist
Hamline University, Minn

Richard G. Werth
Concordia College, Minn

Task Force to Develop Guidelines for the Preparation and Continuing Education of Secondary School Teachers of Chemistry

Task Force Steering Committee

Stanley Kirschner, *Chairman*
Department of Chemistry
Wayne State University, Mich

Theodor Benfey
Department of Chemistry
Guildford College, North Carolina
(Editor, *Chemistry* magazine)

Curtis Dhonau
Vincennes University Junior College, Indiana

William Elliott
Manager, Education Services
American Cyanamid Co. N J

Bernard Friedman, Past President
American Chemical Society
7321 South Shore Drive
Chicago, Il 60649.

Marjorie H. Gardner
Departments of Chemistry and Secondary Education
University of Maryland

Margaret Henley
Kennedy High School
Los Angeles, Calif

Lloyd Johnson
United States Office of Education
Washington, D C

Edwin M. Larsen
Department of Chemistry
University of Wisconsin

W. T. Lippincott, Editor
Journal of Chemical Education
University of Arizona

Arthur H. Livermore
American Association for the Advancement of Science
Washington, D C

William L. Marshall
Oak Ridge National Laboratory, Tennessee

Kathryn P. McHugh
Amundsen High School, Chicago

Richard J. Merrill
Consultant in Secondary Curricula
Mt. Diablo Unified School District, Calif

Joseph S. Schmuckler
Science Education and Chemistry
Temple University, Pa

Leo Schubert
Department of Chemistry
American University
Washington, D C
(Editor, *Journal of College Science Teaching*)

Glenn T. Seaborg, Past President
American Chemical Society
University of California

Sidney Simandle
Kentucky State Dept of Education

Laurence Strong
Department of Chemistry
Earlham College, Indiana

Gardner W. Stacy
Department of Chemistry
Washington State University

Staven N. Vamvakis
Delsea Regional High School, N J

Jay A. Young
Individualized Science—Instructional System
Florida State University

APPENDIX IV

Task Force Writing Committee

† **Jay A. Young**, *Chairman*
Individualized Science
Instructional System
Florida State University*

Herbert Bassow
Germantown Friends School, Pa

† **Henry A. Bent**
Department of Chemistry
North Carolina State University

Richard Bliss
Director of Curriculum Development
Institute for Creation Research
San Diego, Calif

Lealtyn B. Clapp
Department of Chemistry
Brown University, R I

Richard C. Clark
Consultant, Science Education
Minnesota State Dept of Education

Sister Anna Maria Coverdell
Mercy High School
Omaha, Neb

†† **Marjorie H. Gardner**
Departments of Chemistry and
Secondary Education
University of Maryland

† **Henry Heikkinen**
Departments of Chemistry and
Secondary Education
University of Maryland

† **Margaret Henley**
Kennedy High School
Los Angeles, Calif

†† **W. T. Lippincott, Editor**
Journal of Chemical Education
Department of Chemistry
University of Arizona

Arthur M. Livermore
American Association for the
Advancement of Science
Washington, D C

Marilyn Lucas
Euclid High School, Ohio

Aubrey L. McClellan
Chevron Research Company, Calif

L. Myles Phipps
West Valley High School, Wash

Gerald Sughroue
Nebraska Department of Education

Lee R. Summerlin
Department of Chemistry
University of Birmingham, Ala

††† **Frank X. Sutman**
College of Education
Temple University, Pa

Katharine Weissman
C S Mott Community College, Mich

† **Paul H. Westmeyer**
University of Texas at San Antonio

Steven N. Vamvakis
Delsea Regional High School, N J

Pamela Ayre and
Patricia M. Lemaire, Task Force
Liaisons, General
Educational Activities
American Chemical Society

* Current address Manufacturing Chemists Association, Washington D C † Editorial Committee †† Consultants to the Writing Committee ††† Contributed by mail only

APPENDIX V

Reviewers of Preliminary Drafts

As indicated in the historical account (Appendix I) reviewers from within and without the fields of chemistry and science education were invited to criticize preliminary drafts of these Guidelines That more than 80 percent of the more than one-hundred persons asked did respond is both a credit to their patience and an affirmation of the recognition such experts and authorities attributed to the need for a Guidelines document.

A public expression of gratitude and appreciation to these persons is herewith tendered by the project personnel The errors of omission and commission that still remain are to be attributed to the latter (not the former), even though it was not possible to include all of the suggestions received

For the information of the readers and users of these Guidelines the categories of reviewers are listed below.

- Academic Program Coordinators
- ACS Local Sections
- Associations of Boards of Education (State and Local)
- Associations of Science Educators
- Associations of Science Teachers
- Chemical Industry Management Associations
- Chemists employed in Government Service (Federal and State).
- College and University Accrediting Agency Associations
- Coordinators for Secondary School Accreditation
- County Board of Education
- Deans of Graduate Schools
- Educational Associations
- Industrial Chemists
- In-Service Students (preparing to become teachers of Chemistry)
- National Associations of Secondary School Executives
- National Education Commissions and Councils
- National Scientific Societies
- Professional Teachers Unions
- Professors of Chemistry
- Professors of Education
- Professors of Physics
- Professors of Science Education
- School board Members
- Science Curriculum Project Directors
- Science Supervisor Associations
- Science Supervisors
- Secondary School Chemistry Curriculum Chairpersons
- Secondary School Chemistry Teachers
- Secondary School Principal Associations
- Secondary School Principals
- State Boards of Education
- State Departments of Education
- State Science Supervisors
- State Supervisors of Education
- Teacher Accrediting Organizations

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Special thanks and appreciation are herewith accorded to Dr Jay A Young, the Chairman of the Writing and Editorial Committees, for the extraordinary effort he has put into the formulation of these Guidelines Any success they achieve in helping to improve secondary school instruction in chemistry in the United States will be due in large part to his work

Stanley Kirschner, Chairman
Steering Committee ACS Guidelines Project

The Final Word:

Provocative Responses from Selected Reviewers

"I am afraid I see nothing in your pious, bland, inoffensive guidelines that is going to shake up the deep-seated complacency and educational incompetence that pervades the science education scene."

"Is your group willing to say that forcing students in introductory courses to memorize the atomic orbital schemes, without any idea of where such arcane gibberish comes from or how it is validated, is a travesty of education and a hideous, antagonizing trauma for the students?"

"Laboratory-oriented chemistry programs are going down the drain presently, because of drastic cutbacks in supply and equipment allotments in science combined with double digit inflation. The sentence [in Recommendations to Local Officials] 'Respond to the teachers' identified needs for expendable supplies and equipment maintenance.' is not adequate to focus on what is the most important problem facing secondary school science teachers."

"Many (not all) of your recommendations are going to suffer because they simply cost money. Why don't you add a recommendation at least to the school boards pointing out that this is their responsibility: To inform the voting public, and plainly, that even mediocre schools cost a lot of money these days, and that the needed money has to come from the voters' pockets, or else."

"Your excellent suggestions for improving professional education are not paralleled by equally strong statements on reforming college chemistry teaching. I personally do not think revising professional education will have much effect if there isn't a similar reform in college chemistry teaching."

"Your document should hit chemists *hard*. Chemists must assume more responsibility for recruiting and encouraging persons to become high school chemistry teachers. Your document includes several ideas that, if adopted by a university, would eliminate some of the problem; but you are too soft and leave too much to chance by not stating emphatically that more *well trained* chemistry teachers are needed, and the college chemistry professors must take more responsibility for *their* recruitment."

"It has been my experience that there is little cooperation between the chemistry and science education departments. The chem department looks down its nose at science ed. and the science ed. department is too busy doing mickey mouse stuff to bother about teaching practical methods."

"We still say that colleges should offer worthwhile courses for teachers to update their knowledge, and that college science departments should work with college science education departments but, as a matter of fact, they usually do not."

"A cooperative effort is absolutely essential. Chemists, high school chemistry teachers, and professional educators each have a lot to contribute. Each has a unique base of knowledge and experience which when molded together by mutual respect will produce effective chemistry teacher preparation programs."