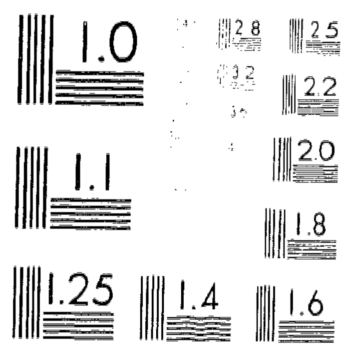

1.0
2.8
2.5
3.2
2.2
2.0
1.1
1.8
1.25
1.4
1.6

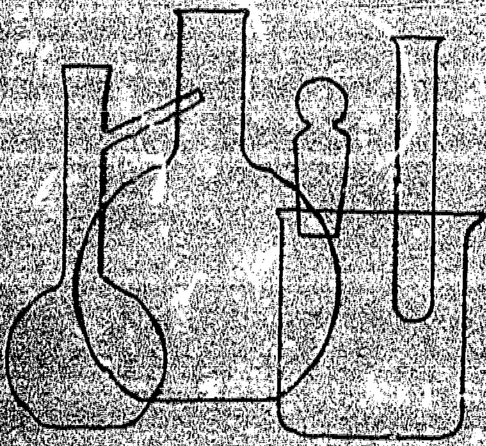
DOCUMENT RESUME

ED 128 223 SE 021 320

AUTHOR	Bardole, Jay, Ed.
TITLE	Chemistry in the Two-Year College, Vol. 12, 1974.
INSTITUTION	American Chemical Society, Easton, Pa. Div. of Chemical Education.
PUB DATE	74
NOTE	98p.; For related documents, see SE 021 314-319
EDRS PRICE	MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS	*Chemistry; College Science; Community Colleges; *Conference Reports; Conferences; *Curriculum; Health Personnel; *Higher Education; *Instruction; Junior Colleges; Laboratory Safety; Safety; Science Education

ABSTRACT

This publication, issued twice per year, includes proceedings from Two-Year College Chemistry Conferences and papers of special interest to the two-year college chemistry teacher. Both chemical safety in the laboratory and the integration of laboratory work with teaching are discussed. Also discussed are topics related to the teaching of first-year general chemistry and second-year organic chemistry. Additional topics include allied health chemistry and chemistry for the nonscience student. (MH)



CHEMISTRY IN THE TWO-YEAR COLLEGE

VOLUME XII 1974

COMMITTEE ON CHEMISTRY IN THE TWO-YEAR COLLEGE
DIVISION OF CHEMICAL EDUCATION · AMERICAN CHEMICAL SOCIETY

Foreword

We are pleased with the quality of material presented in this volume of Chemistry In The Two Year College. Also, we are now only one year behind in our publication; if things continue at the present rate, the first volume of 1977 should be current.

Over the past five years, Conference Editors have been responsible for getting papers from a conference and submitting them to the Journal Editor. It is their prompt and thorough work which supply us with the papers to put in our Journal. This is time consuming work and often difficult to get these papers. We all owe these people more thanks than we usually express. The Conference Editors who supplied the current proceedings were Bill Timberlake from the Pasadena meeting, Rhonda Rider from the Tallahassee meeting and Douglas Jardine from the large Regina meeting.

In addition, we would like to recognize the Regional Chairpersons, who put the programs together for the meetings reported in this Journal. Wanda Sterner of Cerritos College was the Western Regional program chairperson and responsible for the Pasadena meeting. Nina Milton was Southern Vice-Chairperson and responsible for the Tallahassee program. The Canadian Co-Chairpersons were Graham Welch and Jans Diemer and they were responsible for the Regina meeting.

In general our TYC_3 meetings are excellent. They are designed to deal with the problems encountered by two year college chemistry teachers. So that the meetings may continue to be of the same high quality, it is important that we as Junior College Teachers make an effort to attend meetings held in our region. Not only do we benefit from the meetings, but the opportunity for informal exchange with our colleagues is invaluable.

Jay Bardole
Editor

Industrial Sponsors

Addison Wesley Publishing Co.
Reading, Mass. 01967

Bel Arts Products
Pequannock, N. J. 07440

Burgess Publishing Co.
7108 Ohms Lane
Minneapolis, Minn. 55435

Canfield Press
850 Montgomery Street
San Francisco, Calif. 94133

Carle Instruments Inc.
1141 E. Ash Ave.
Fullerton, Calif. 92631

Dickenson Publishing Co.
16561 Ventura Blvd.
Encino, Calif. 91316

Roger Gilmont Instrument Inc.
159 Great Neck Road
Great Neck, New York 11021

Gow-Mac Instrument Co.
100 Kings Road
Madison, New Jersey 07940

Kontes Glass Co.
Spruce Street
Vineland, New Jersey 08360

Lab Aids Inc.
130 Wilbur Place
Bohemia, New York 11716

Mosby Times-Mirror
11830 Westline Industrial Dr.
St. Louis, Mo. 63141

Oxford University Press
16-00 Pallitt Dr.
Fair Lawn, New Jersey 07410

Sadtler Research Lab. Inc.
3316 Spring Garden St.
Philadelphia, Penn. 19104

Scott Engineering Sciences
910 S.W. 12th Ave.
Pompano Beach, Florida 33060

Scott, Foresman & Co.
1900 E. Lake Ave.
Glenview, Ill. 60025

Spectrex Corporation
3594 Haven Ave.
Redwood City, Calif. 94063

Technicon Instruments Corp.
Benedict Ave.
Tarrytown, New York 10591

The Torsion Balance Co.
125 Ellsworth St. Box 535
Clifton, New Jersey 07012

Varian Associates
611 Hansen Way
Palo Alto, Calif. 94303

Wadsworth Publishing Co.
10 Davis Drive
Belmont, Calif. 94002

The Wentar Company
2231 Bullinger
Wichita, Kansas 67204

John Wiley & Sons, Inc.
605 Third Avenue
New York, New York 10016

Willard Grant Press
20 Newbury Street
Boston, Mass. 02116

Wilmad Glass Co. Inc.
U.S. 40 and Oak Road
Bueno, New Jersey 08310

College Sponsors

Aims Community College
5401 W. 20th St.
Greeley, Col. 80631

Albany Junior College
2400 Gillionville Road
Albany, Georgia 31707

Community College of Allegheny Co.
595 Beatly Road
Monroeville, Penn. 15146

Community College of Allegheny Co.
West Mifflin, Penn. 15122

Atlantic Community College
Black Horse Pike
Mays Landing, New Jersey 08330

Community College of Baltimore
Baltimore, Maryland 21215

Black Hawk College
Moline, Ill. 61265

Blue Ridge Community College
Box 80
Weyer's Cave, Virginia 24486

Brevard Community College
1519 Clearlake Road
Cocoa, Florida 32922

Cazenovia College
Elkton, Maryland 21921

Chemeketa Community College
Salem, Oregon 97303

Clearemore Jr. College
Clearemore, Oaklahoma 74017

Colorado Mountain College
Glen Woods Springs, Colorado 81601

Cuyahoga Community College
7300 York Road
Parma, Ohio 44130

Dallas County Community College
Main & Lamar
Dallas, Texas 75202

Dawson College
300 College Drive
Slendive, Montana 59330

DeAnza College
21250 Stevens Creed Blvd.
Cupertino, Calif. 95014

Community College of Denver-
N. Campus
1001 E. 62nd. Ave.
Denver, Col. 80216

El Camino Community College
Torrence, Cal. 90506

Elgin Community College
1700 Spartan Drive
Elgin, Ill. 60120

El Paso Community College
2200 Bott Avenue
Colorado Springs, Col. 80904

Essex Community College
7201 Rossiville Road
Baltimore, Maryland 21237

Foothill College
Foothill Community College Dist.
Los Altos Hills, Cal. 94022

Fort Scott Community College
Fort Scott, Kansas 66701

Gainsville Jr. College
P.O. Box 1358
Gainsville, Georgia 30501

Garden City Community College
Garden City, Kansas 67846

Grand Rapids Jr. College
Grand Rapids, Mich. 49502

Green River Community College
Auburn, Wash. 98002

Greenville Technical College
P.O. Box 5616 Station B
Greenville, S.C. 29606

Wm. Rainey Harper Community Col.
Palatine, Ill. 60067

Hinds Jr. College
Raymond, Miss. 39154

Holyoke Community College
303 Homestead Ave.
Holyoke, Mass. 01040

Hudson Valley Community College
80 Vandenburg Ave.
Troy, New York 12180

Hutchinson Community Jr. College
1300 North Plum
Hutchinson, Kansas 67501

Iowa Western community College
Council Bluffs, Iowa 51501

Isothermal Community College
P.O. Box 804
Spindale, North Carolina 28160

Jackson Community College
Jackson, Miss. 49201

Kennedy King College
6800 S. Wentworth Ave.
Chichago, Ill. 60621

Kishwaukee College
Malta, Ill. 60150

Dabney S. Lancaster Comm. College
Box 350 Clifton Forge, Va. 24422

Laney College
Oakland, Cal. 94606

Laramie County Comm. College
1400 E. College Drive
Cheyenne, Wyom. 82001

Lewis and Clark Community College
District 536
Godfrey, Ill. 62035

Linn-Benton Community College
Albany, Oregon 97321

Longview Community College
500 Longview Road
Lee's Summit, Missouri 64063

Lorain County Community College
Elyria, Ohio 44035

Louisburg College
North Main Street
Louisburg, N. C. 27549

Manor Junior College
Fox Chase Road & Forrest Ave.
Jenkintown, Penn. 19046

McHenry County College
6200 Northwest Highway
Crystal Lake, Ill. 60014

Meramec Community College
11333 Big Bend Blvd.
Kirkwood, Missouri 63122

Mesa College
1175 Texas Ave.
Grand Junction, Col. 81501

Middle Georgia College
3rd Street
Cockian, Georgia 31014

Univ. of Minn. Technical College
Crooketon, Minn. 56716

Mohegan Community College
Norwick, Conn. 06360

Monroe Community College
1000 East Henrietta Road
Rochester, New York 14623

Monterey Peninsula Comm. College
980 Fremont Blvd.
Monterey, Cal. 93940

Charles Stewart Mott Comm. Col.
1401 East Court Street
Flint, Mich. 48503

Murray State College
Tishomingo, Oaklahoma 73460

Nashville State Technical Inst.
120 White Bridge Road
Nashville, Tenn. 37209

Nassau Community College
Garden City, New York 11533

North Iowa Area Comm. College
Mason City, Iowa 50401

North Seattle Community College
9600 College Way North
Seattle, Wash. 98103

North Shore Community College
3 Essex Street
Beverly, MA 01915

Oakland Community College
2900 Featherstone Road
Auburn Heights, MI 48057

Pasadena City College
Pasadena, Cal. 91106

Pennsylvania State University

Penn Valley Community College
3201 Southwest Trafficway
Kansas City, Missouri 64111

Pima Community College
2202 W. Anklam Road
Tucson, Arizona 85709

Polk Community College
999 Avenue H, NE
Winter Haven, Florida 33880

Catholic Univ. of Puerto Rico
Ponce, Puerto Rico

Reedley College
Reedley, Calif. 93654

Roane State Community College
Harriman, Tenn. 37748

Saddleback Community College
Mission Viejo, Cal. 92675

St. Mary's College of O'Fallon
200 N. Main St.
O'Fallon, Missouri 63366

San Antonio College
1300 San Pedro Ave.
San Antonio, Texas 78284

Scottsdale Community College
P.O. Box Y
Scottsdale, Arizona 85252

Sheridan College
Sheridan, Wyoming 82801

Sinclair Community College
444 W. Third St.
Dayton, Ohio 45402

Spring Garden College
102 E. Mermaid Lane
Chestnut Hill, Penn. 19118

Triton College
River Grove, Ill. 60171

Vincennes University
1002 N. First
Vincennes, Ind. 47591

Wesley College
Dover, Delaware 19901

Westark Community College
P.O. Box 3649
Fort Smith, Ark. 72901

Westchester Community College
Valhalla, N.Y. 10695

Western Wyoming Community College
Rock Springs, Wyoming 82943

Westmoreland County Comm. College
New Wilmington, Penn. 16142

Wingate College
Wingate, North Carolina 28174

Canadian Industrial Sponsors

General Audio-Visual Company

Sargent-Welch Scientific of Canada Ltd.

Xerox of Canada Ltd.

Canadian College Sponsors

British Columbia Institute of Technology
British Columbia

College of Cape Breton
(Eastern Tec. Campus)
Nova Scotis

College of Trades and Technology
St. John's, Newfoundland

Dawson College
(Lafontaine Campus)
Quebec

John Abbott College
Quebec

Malaspina College
British Columbia

Medicine Hat College
Alberta

Mohawk College of Applied Arts and Technology
Ontario

Northern Institute of Technology
Alberta

Sault College of Applied Arts and Technology
Ontario

Sheridan College of Applied Arts and Technology
(Brampton Campus)
Ontario

Sir Sandford Fleming College of Applied Arts and Technology
Ontario

St. Clair College of Applied Arts and Technology
(Kingston)
Ontario

St. Lawrence College of Applied Arts and Technology
(Brockville)
Ontario

St. Lawrence College of Applied Arts and Technology
(Kingston)
Ontario

Vanier College
(Snowdon Campus)
Quebec

Table of Contents

ALLIED HEALTH CHEMISTRY

SECOND YEAR CHEMISTRY

CHEMISTRY FOR NON-SCIENCE MAJORS

CHEMICAL SAFETY

The Literature of Chemical Safety

Joyner Sims
Chipola Junior College
Marianna, Florida 32446

Presented to the Symposium on Safety, Thirty-Ninth, Two-Year College Chemistry Conference, Tallahassee, Florida, May 10, 1974.

A monthly feature article on "Safety in the Chemical Laboratory" has appeared in the Journal of Chemical Education since January, 1964. Articles appearing from 1964 to 1973 have been organized and published in three separate volumes on Safety in the Chemical Laboratory which are described below. These feature articles include extensive references to the literature of chemical safety and they are the one best source of information on safety in the chemical laboratory.

Volume One of "Safety in the Chemical Laboratory" contains an article entitled The Literature of Chemical Safety. The bibliography of this article includes all major books, periodicals, pamphlets, booklets, and data sheets on chemical safety published before 1966. Volume Two of the series contains a sequence of articles which consists of excerpts from seven different safety manuals and handbooks. These few articles alone include extensive and useful references to the literature of chemical safety.

Several sources of information on chemical safety are briefly described below. Only those sources that the author uses frequently in his own work are included.

Sources of Information on Safety in the Chemical Laboratory

1. The Journal of Chemical Education, monthly, Division of Chemical Education of the American Chemical Society, Easton Pennsylvania 18042.

A monthly feature article on Safety in the Chemical Laboratory edited by Norman V. Steere has appeared in the Journal of Chemical Education since January, 1964.

Subscription orders may be addressed to: Subscription Department, Journal of Chemical Education, 20th and Northampton Streets, Easton, Pennsylvania 18042.

2. Norman V. Steere, Ed., "Safety in the Chemical Laboratory" Volumes 1,2, and 3, Division of Chemical Education of the American Chemical Society, Easton, Pennsylvania. 1967 (132 pages), 1970 (132 pages), 1973 (160 pages).

These three volumes contain all the feature articles on "Safety in the Chemical Laboratory" of the Journal of Chemical Education from the beginning of the series in 1964 through

January, 1973. The articles of each volume have been arranged in topical order and an index has been added. Topics range from general information on laboratory safety to specific information on chemical hazards. These volumes are excellent materials for use in high school, undergraduate, graduate, research, and industrial laboratories.

Volumes 1,2,3, are available from the Chemical Education Publishing Company, 20th and Northampton Streets, Easton, Pennsylvania 18042, at a cost of $3.00, $3.50, and $5.50 respectively. Prices for a combination of two or three volumes are slightly lower.

3. Norman V. Steere, Ed., "Handbook of Laboratory Safety" Second Edition, The Chemical Rubber Company, Cleveland, Ohio. 1971, 854 pages.

The reference collection of <u>every</u> chemical laboratory should include a copy of the "Handbook of Laboratory Safety". It includes many of the feature articles from the <u>Journal of Chemical Education</u> and a large number of other contributions which are arranged in topical order and extensively indexed. In addition, the Handbook of Laboratory Safety" contains graphic color photographs of chemical injuries.

4. Manufacturing Chemists Association, "Chemical Safety Data Sheets", and other publications, 1825 Connecticut Avenue, N.W., Washington, D.C. 20009.

Approximately one hundred "Chemical Safety Data Sheets" are available at a nominal cost from the Manufacturing Chemists Association. Each data sheet includes the properties and essential information for the safe handling and use of one substance. These are excellent and essential reference materials.

5. "Guide For Safety in the Chemical Laboratory," Second Edition, Van Nostrand-Reinhold Company, Cincinnati, Ohio, 1972, 505 pages.

The first edition of this book was published in 1954. The second edition is available from Van Nostrand-Reinhold Company, 300 Pike Street, Cincinnati, Ohio 45202, at a cost of $17.50.

6. "Safety in Academic Chemistry Laboratories," American Chemical Society, Washington, D.C. 1974, 40 pages.

"Safety in Academic Chemistry Laboratories" is a booklet prepared by the American Chemical Society Committee on Chemical Safety. One copy of the booklet is available at no charge from the American Chemical Society, 1155 Sixteenth Street, N.W. Washington, D.C. 20036. Additional copies are available at $0.25 each.

7. G.N. Quam, "Safety Practices for Chemical Laboratories," Villanova Press, Villanova, Pennsylvania, 1963, 78 pages.

"Safety Practices in Chemical Laboratories " may be obtained from the Villanova University Press at $1.05 per copy.

8. "Manual of Hazardous Chemical Reactions," Fourth Edition, National Fire Protection Association, Boston, Massachusetts, 1971, 308 pages.

The "Manual of Hazardous Chemical Reactions" is a compilation of chemical reactions which are potentially hazardous. It is available from the National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts 02110 for $3.25 per copy.

9. "Laboratory Waste Disposal Manual," Manufacturing Chemists Association, Washington, D.C., 1969 (Revised, Sept. 1973), 176 pages.

The "Laboratory Waste Disposal Manual" includes information on chemical hazards, procedures for cleaning-up spilled chemicals and disposing of waste materials, and safety references. It is available from the Manufacturing Chemists Association, 1825 Connecticut Avenue, N.W., Washington, D.C. 20009, for $3.50 per copy.

10. "Safety in the Science Laboratory," State Department of Education, Tallahassee, Florida, 1968, 94 pages.

"Safety in the Science Laboratory is Bulletin 74 published by the State Department of Education of the State of Florida. The guidelines set forth in this bulletin are not official regulations of the State Department of Education. The bulletin was prepared to encourage the use of safe practices and procedures in science laboratories in the Florida public schools.

"Safety in the Science Laboratory" is available at no charge from the State Department of Education, Tallahassee, Florida 32304.

11. Richard Tossell, Ed., Campus Safety Newsletter, The Campus Safety Association (part of the School and College Section of the National Safety Council, Chicago, Illinois.

The Campus Safety Newsletter is published by the Campus Safety Association of the National Safety Council. Richard Rossell is editor of the Newsletter. He is Assistant Dean of the School of Public Service at Central Missouri State University at Warrensburg, Missouri 64093. Only members of the Campus Safety Association receive the Campus Safety Newsletter. However, there is no charge for Association Membership. Interested persons may request membership application forms from staff representative, Jack Green, of the School and College Section of the National Safety Council, 425 Nor h Michigan Ave., Chicago, Illinois 60611.

The Campus Safety Association formerly published the Laboratory Safety Newsletter which was edited by Eric W. Spencer, Safety Officer at Brown University. The Campus Safety Newsletter has now replaced this earlier publication.

The Research and Development Section of the National Safety Council also published a safety newsletter. Subscriptions to The Research and Development Newsletter cost approximately $2.00 per year. Inquiries should be directed to the Research and Development Section of the National Safety Council.

12. "Safety Handbook", a part of the Chemical Reference Manual," (Catalog of Chemicals) Volume 1, of the MC/B Manufacturing Chemists, Norwood, Ohio, 1973, 40 pages (Safety Handbook only).

A current MC/B chemical catalog may be obtained at no charge on request from any distributor of MC/B chemicals. Essentially the same information contained in the "Safety Handbook" was formerly published by MC/B as a separate brochure entitled "Safety in Handling Hazardous Chemicals". The separate brochures are no longer available.

13. "Safety in the Chemistry Laboratory", an article by Malcolm Renfrew published in the Proceedings of the Two-Year College Chemistry Conference, 1968-1969 Academic Year, page 21.

William T. Mooney, Jr. of El Camino College, Torrance, California, was chairman of the conference during the 1968-69 school year. Back issues of the Conference proceedings may be available. The article by Malcolm Renfrew contains excellent general information on safety in chemistry laboratories.

14. Chapter 65-526 of the Florida Statutes includes House Bill 508, which became law in the state of Florida on June 25, 1965. This bill requires that eye protection devices be used in certain vocational and chemical laboratory courses.

Copies of the Florida law may be obtained from the Legislative Information Division, Room 94, Holland Building, Tallahassee, Florida 32304.

15. Prairie State Products Company (Safety Signs), 3822 Lawrence Avenue, Chicago, Illinois.

All kinds of Safety Signs may be ordered from the Prairie State Products Company.

16. Acton Associates, 100 Thompson Street, Pittston, Pennsylvania 18640.

Acton Associates are suppliers of HgX, a mercury decontaminant, and safety wall placards related to the handling of mercury and mercury compounds.

17. "Eye and Face Protection in Chemical Laboratories," a 131/2 minute film distributed by the Florida Society for the Prevention of Blindness.

"Eye and Face Protection in Chemical Laboratories" is an excellent film available for use at no charge from the Florida Society for the Prevention of Blindness, 5501 West Gray Street, Tampa, Florida 33607. The National office of the Society for the Prevention of Blindness also distributes this film.

18. "Emergency Procedures for Dangerous Materials", a wall chart available from Science Related Materials, Inc., Evanston, Illinois 60204.

"Emergency Procedures for Dangerous Materials" is a wall chart which contains convenient and color coded information on dangerous materials. The cost per chart is approximately ten to fifteen dollars.

Safety Measures, Laws and Chemists

Norman V. Steere
140 Melbourne Ave.
Minneapolis, Minn. 55414

Presented to the Symposium on Safety, Thirty-Ninth Two-Year College Chemistry Conference, Tallahassee, Florida, May 10, 1974.

I understand that the chemical abstract service has indicated that they are trying to get their abstractors to emphasize safety in their abstracting. They are going to try to pay particular emphasis in the abstract to safety; so that, in the future they will be able to tell about safety related to whatever thing you are working with. This type of information should pull out things like unexpected pressure rise, susceptibility to decomposition,etc. However, I think one of the problems is that "they ain't going to find no more than they find out now, if everybody is as bashful in the chemical fraternity as they are about letting it all hang out, in telling what happened when an accident occurs!"

It's a real pleasure to visit campuses and talk to people about accidents that have never been written up in the chemical literature. You'll never find them! In a way, being human, nobody likes to point the finger of blame at themselves. Not reporting is one of the problems with accidnets! If we're going to carry out chemical education it is very important that we try ourselves and teach our students to report what happens in a scientific manner. I think about one experience I had. I was talking with a Librarian at the University of Minnesots, when she mentioned that one of the sisters who had gotten her PhD in Chemistry had been over to the student health service with a persistant skin problem that was very difficult to clear up. We found out that her research had been on organic tin, which has certain toxic properties. We looked at her thesis and there was nothing in her thesis that even suggested the possibility that one should exercise a certain amount of caution in handling these compounds. Now certainly it would not be appropriate in a thesis to say "my skin broke out because I was sloppy". You are not going to do that; but you know there is language that can be used to leave a trail for the people that follow behind. There is an awful lot of rediscovering of the wheel that takes place that is very unfortunate. I'd like to say that in my associations with scientists, the chemist generally speaking, pays more attention to safety than some brothers in other disciplines. The refrigerator I expect to find the ether in is a biologists' refrigerator. It seems that as chemists you should have some sort of safety committee in your college or wherever, to try to pass on the information about accidents and dangers associated with the use of chemicals that you are personally aware of.

Some of the recorded slides that Joyner points out that are published in the Handbook of Laboratory Safety are available from Medical Graphic Arts, Lake Jackson, Texas. These are taken by an industrial physician, who moonlights; he has taken pictures of what happens in his facility. If you want to buy a set of goree slides showing chemical and tramatic injuries to the eye or chemical injuries to the skin, you can obtain these from Medical Graphic Arts.

My topic "Pending Safety Measures and Laws" implies that nothing has really happened to trouble you; that things are on the horizon. If you haven't heard about it, there is an Occupational Safety and Health Act and it applies to essentially all employees. There has been an exemption for municipal, state, government, and state university employees which may have exempted you in the past, but now states are adopting plans. I have to confess I don't know if Florida is adopting a state plan or not. Without getting into the question of does the occupational safety and health act apply to you, I would like to at least talk about some things in the Act that you may have to be concerned about.

Basically it's limited to employees. It doesn't have anything to do with the protection of patents; it doesn't have anything to do with the protection of students, but if the people you are teaching are to be working at hospitals it applies. Now some of you might think: "Hey, I'm an employee, what are we doing to protect me from my work situation?"

Some highlights of the act are: Each employer shall furnish to each of his employees a place of employment which is free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees. Under the Act the employer should be able to show that training has been given to employees based on an analysis of the task performed by the employee.

I haven't been able to find, but I suppose it is done, how much of an analysis of the hazards of various laboratory experiments, research, etc. has been made. I've had the feeling, in my University experience that very often people went for research grants without asking for the money to provide for safety. There was the fellow that worked with vanadium oxytrichloride who felt that he could stand there and everything would blow away from him instead of against him. Safety should be included in proposals for a new building, laboratories, research, etc.!

OSHA was given the responsibility for adopting standards for safety in a work place and essentially what they did was to go out and look at what was in existance. The National Fire Protection Association is considered a consences standards making organization. They publish what they propose to establish as their standards. You can learn about this, you can go to the meeting, comment, become aware of, and participate in setting standards for laboratory safety. I would like to invite you to the meeting in Miami two weeks from now as a lobbyist. I need help - you need help!

The standards they picked up were written by industry and for industry. Standards are set by ad hoch committees, perhaps not representing a consensus of standards at all. The make up of these committees is sometime a result of who can get financial support to get there. The National Association of Sprinkler Contractors is represented on every major NFPA committee that has sprinkler business in it! All of the standards in OSHA have not really been tried out, but they are based on the experiences of companies that have the good safety practices and were interested in getting there and participating in the standards making operations.

Labor people, small fire departments, etc. are poorly represented. There was only one chemist on the committee that was drafting the NFPA Standards for Laboratories. There are no standards in the federal regulations really written for laboratories. Two or three years ago NFPA wrote a standard for hospitals, set by safety engineers which may not be practical or realistic.

We have got to do more work to report our accidents, analyze our accidents and explosions; so that we know what we are trying to protect against. OSHA has not gone into laboratories - they did go in to inspect MIT because they had an electrical fatality there. That report has been published in the Proceedings of the National Safety Congress in their 1973 October meeting. One of their priorities is to go in to inspect in case of fatalities.

In summary they found:

- 453 compressed gas cylinders stored improperly
- 48 chemical and solvents stored improperly (they could find as many in most laboratories)
- 370 pulleys not properly guarded (vacuum pumps, etc.)
- 10 exposed electrical parts over 600v
- 15 electrical supplying circuits not properly grounded over 50 v
- 135 fire extinguishers not mounted

Regulation of Laboratory use of certain Carcinogenic Chemicals

The Occupational Safety and Health Administration, U.S. Department of Labor, has adopted permanent standards regulating storage and use of fourteen chemicals shown to cause cancer in humans or animals. Published in the Federal Register on Tuesday, January 29, 1974, with background and documentation, the standards regulate laboratory use of the chemicals as well as general industrial use. The chemicals, listed on the following pages, include six that are regulated at any concentration of 0.1% or greater and eight regulated at 1.0% or greater concentration. Included are benzidine and its salts, 3,3'-dichlorobenzidine and its salts, ethyleneimine, bis-chloromethyl ether, alpha- and beta-naphthylamine, and beta-propiolactone.

The standards called for reporting by March 1, 1974 of the address and location of every area where any of the carcinogens are stored, handled, released, or repackaged, the manner in which the chemicals are present in each area, and the number of employees that enter storage or use areas during operations or maintenance. The required reports are to be filed with the Area Director or OSHA. (OSHA Standards apply directly to all private laboratories, by Executive Order to Federal laboratories, and under state plans to other governmentally-funded labs.)

In order to comply with the OSHA Standards on fourteen carcinogens laboratory management should take the following steps immediately:

1. Inventory laboratory chemicals in use and storage to find any regulated concentrations of the carcinogens;
2. Evaluate chemical reactions in use to determine whether regulated concentrations of the carcinogens are produced incidentally;
3. Gather all regulated carcinogens into the minimum number of isolated systems (fully enclosed structures such as glove boxes);
4. Determine which chemicals in regulated concentrations are essential;
5. Neutralize and safely dispose of those chemicals found not essential;
6. Establish regulated areas with restricted and controlled entry and exit wherever the carcinogens are to be stored or used (eg. glove boxes);
7. Prepare the required reports to the OSHA Area Director;
8. Establish required hygiene facilities and practices;
9. Establish required incident reporting system, emergency procedures, and decontamination procedures;
10. Establish required operation and maintenance procedures;
11. Post regulated areas with signs at entrances with the legend: "CANCER-SUSPECT AGENT AUTHORIZED PERSONNEL ONLY";
12. Label containers with the warning: "CANCER-SUSPECT AGENT";
13. Establish and maintain for 20 years a roster of employees entering regulated areas;
14. Establish and implement required training and indoctrination program for all affected employees;
15. Establish the required medical surveillance program, including preassignment and annual physical exams.

CHEMICALS REGULATED BY CARCINOGENS STANDARDS OF O.S.H.A.

	Chemical	CA Registry #	OSHA Standard	(page #)
	1. 2-Acetylaminofluorene Regulated at 1.0% or greater concentration	(CA# 53963)	1910.93n	(3789)
	2. 4-Aminodiphenyl Regulated at 0.1% or greater concentration (also known as 4-Biphenylamine)	(CA# 92671)	1910.93k	(3781)
*	3. Benzidine and its salts Regulated at 0.1% or greater concentration	(CA# 92875)	1910.93j	(3779)
	4. bis-Chloromethyl ether Regulated at 0.1% or greater concentration	(CA# 542881)	1910.93h	(3773)
	5. 3,3'-Dichlorobenzidine Regulated at 1.0% or greater concentration	(CA# 91941)	1910.93g	(3771)
*	6. 4-Dimethylaminoazobenzene Regulated at 1.0% or greater concentration (also known as Butter yellow, and C. I. Solvent yellow2)	(CA# 60117)	1910.93o	(3792)
	7. Ethyleneimine Regulated at 1.0 % or greater concentration (also known as Aziridine)	(CA# 151564)	1910.93l	(3784)
	8. Methyl chloromethyl ether Regulated at 0.1% or greater concentration	(CA# 107302)	1910.93f	(3768)
	9. 4,4'-Methylene bis(2-chloroaniline) Regulated at 1.0% or greater concentration (also known as MOCA)	(CA#101144)	1910.93e	(3765)
*	10. alpha-Naphthylamine Regulated at 1.0% or greater concentration	(CA# 134327)	1910.93d	(3762)
	11. beta-Naphthylamine Regulated at 0.1% or greater concentration	(CA# 91598)	1910.93i	(3776)
	12. 4-Nitrobiphenyl Regulated at 0.1% or greater concentration	(CA# 92933)	1910.93c	(3760)
	13. N-Nitrosodimethylamine Regulated at 1.0% or greater concentration (also known as Dimethyl nitrosamine)	(CA# 62759)	1910.93p	(3794)
*	14. beta-Propiolactone Regulated at 1.0% or greater concentration	(CA# 57578)	1910.93m	(3786)

CHEMICALS DESIGNATED CARCINOGENIC IN O. S. H. A. STANDARD

with cross-references to recognized synonyms

1.	2- Acetylaminofluorene	
	N- Acetyl-2-aminofluorene	(1.)
	4- Aminobiphenyl	(2.)
2.	4- Aminodiphenyl	
	p- Aminodiphenyl	(2.)
	1- Aminonaphthalene	(10.)
	2- Aminonaphthalene	(11.)
	Azacyclopropane	(7.)
	Aziridine	(7.)
3.	Benzidine and its salts	
	Betaprone	(14.)
	4- Biphenylamine	(2.)
	p-Biphenylamine	(2.)
4.	bis Chloromethyl ether	
	Butter yellow	(6.)
	C. I. Solvent Yellow 2	(6.)
	4, 4'- Diaminobiphenyl	(3.)
	4,4'- Diamino-3, 3'-dichlorobiphenyl	(5.)
	4, 4'- Diaminodiphenyl	(3.)
	p- Diaminodiphenyl	(3.)
5.	3, 3'- Dichlorobenzidine	
	3, 3'- Dichloro-4, 4'-biphenyldiamine	(5.)
6.	4- Dimethylaminoazobenzene	
	Dimethylenimine	(7.)
	Dimethylnitrosamine	(13.)
	N, N- Dimethyl-p-phenylazoaniline	(6.)
7.	Ethyleneimine	
	N-2- Fluorenylacetamide	(1.)
	Hydracrylic acid, β-lactone	(14.)
8.	Methyl chloromethyl ether	
9.	4, 4'- Methylene bis(2-chloroaniline)	
	Methylene-bis-orthochloroaniline	(9.)
	Methyl yellow	(6.)
	MOCA	(9.)
	Naphthalidam	(10.)
	Naphthalidine	(10.)
10.	alpha- Naphthylamine	
	1- Naphthylamine	(10.)
11.	beta- Naphthylamine	
	2- Naphthylamine	(11.)
12.	4- Nitrobiphenyl	
	p- Nitrobiphenyl	(12.)
	p- Nitrodiphenyl	(12.)
13.	N- Nitrosodimethylamine	
	2- Oxetanone	(14.)
	Propanolide	(14.)
14.	beta- Propiolactone	
	β- Propionolactone	(14.)
	Xenylamine	(2.)

They found the kind of things that even freshmen would find if told to look for hazards. There could have been volumes writted on MIT if more of their experienced personnel became involved.

If facilities spend money to correct the things that OSHA is concerned about they may correct the obvious things and miss things that are more significant and have more consequence in the long run. For example:

Fire alarm systems
Ways of getting out of buildings without being trapped
Ventilation to prevent toxic exposure
Proper control of flammable liquids

If you are going to go into this thing it is not only necessary to determine what your problems are, but to att ch some sort of priority to their solution.

Sample exposures with your GC (know if they are reasonable)
A hose is effective for eye wash and acceptable by OSHA Standards
Carcinogens must be reported by private institutions. Regulations must be posted and records kept. Get them into a glove box and call that your regulated area.
Keep records of extent of exposure to substances like vinyl chloride.

The Journal of Chemical Education would be willing to publish good reports of accidents where you have taken looks at what the causes are--no names - no identification. If you can reach the people in your field faster in a specialized journal - go that route--but do try to get the thing published! If you have inquires or any information that would fit the Journal you are encouraged to submit them.

Some potential hazards:

Don't have coffee in the laboratory
Don't refrigerate chemicals with food
Guard vaccuum belts.
Don't have solvents in gallon glass bottles, unless you need it for purity and you use more than two ounces at a time. Use metal cans, at least.
Transport in carriers, fastened down.
If a gallon of solvent becomes ignited, you have 900°F near a room's ceiling in one minute!
No ether in 5 gallon cans
What do you have near ignition sources.
Blocked exits.
Proper storage cabinets with fire protection will be cooler than 325°F, when the outside temperature is 1300, after 10 minutes.

Legal Responsibility in the Chemistry Laboratory

Charles E. Miner
General Legal Counsel
Florida State Board of Health

Presented to the Symposium on Safety, Thirty-Ninth, Two-Year College Chemistry Conference, Tallahassee, Florida, May 10, 1974.

The topic that has been given me this afternoon, oddly enough, has to do with legal responsibility in connection with chemistry and chemistry laboratories. I am going to outline what I think are the general rules, that are attained in probably all states of the union. I have a number of case studies that I am going to go into toward the end of my remarks.

Could I have a show of hands please of how many of you own homes and homeowner insurance policies. Now I am told by Mr. Ringer that a number of you come from states other than Florida. I would imagine,that as in Florida, in your states you have what is known as the "Doctrine of Sovereign Immunity". We have it in Florida at the moment, as of January 1975 we will no longer have the protection that is afforded through sovereign immunity. Soverign immunity in essence says that the sovereign can do no wrong, consequently the only way you can sue the sovereign is with the consent of the sovereign. For many years that same protection has been extended to persons who were employees of the sovereign for their negligent acts that occured within the realm of their authority; but sovereign immunity is on its way out here in this state. If it is not gone now, it will go! The feeling among the legislators is that "Why should a state be immune from the results of its negligent acts committed through its employees.

I asked about your home owners insurance because - if you will look at your policy you will see that section two of that policy is a comprehensive personal liability section which protects you within the limits of that policy from your negligent acts whether they occur in your home or in your classrooms. If that policy does not contain a comprehensive personal liability section, then a visit to your insurance agent can protect you. Some of you have probably been afforded protection from your negligent acts through whatever associations you may belong to. I think that the Florida Education Association provides a plan of insurance and I suspect that some of your state associations likewise do.

Laboratory safety in the classroom, I am confident, is on your mind; it's probably on the minds of youngsters who are injured in your laboratory and their parents. The standard of care that usually attains throughout the United States is that of a "Reasonable and Prudent Person". I have never really understood what a reasonably prudent person is, although I am supposed to deal with these people day in and day out. When we talk of a reasonably prudent person we are not talking in terms of a reasonably prudent janitor, we are talking in terms for our discussion today, of a reasonably prudent teacher of chemistry in the classroom.

The standard of care that the courts of these United States generally require is the standard of "Ordinary Care". What constitutes ordinary care, how can you protect yourself? There are really only three elements; and they are the elements that I have found in every case that we have been able to discover, of laboratory safety.

Instruction It is the uninstructed student who generally finds himself in trouble in the laboratory. You have an affirmative responsibility; that is the first thing made of an inquiry when somebody attempts to apply the so called "doctrine of the deep pocket" to you; that is the first way and the quickest way of getting one's attention is whether or not you instructed your students of the potential hazards in the experiment involved. There is no substitute for fully informing persons in your laboratory who are going to be involved in a classroom where experiments are taking place of the hazards involved.

Maintenance The maintenance of the laboratory and of safe conditions is the responsibility of the instructor. I can cite an example:

A candy thermometer was taken into a Home Economics Laboratory when students were making taffey. The thermometer was very old, but was taken from its box, as it had never been used. The student dropped the thermometer, but as far as could be detected by examination no damage was done. She placed it in a solution that was hotter than the thermometer could bare and it exploded, putting out both eyes. The mercury was embedded into the side of her face and eventually she died of mercury poisoning. There was no instruction on the box that indicated the temperature limit. The manufacturer, the one Home Economics teacher both were subjected to a law suit and the young girl was awarded over $500,000 prior to her death.

Supervision Supervision is equally important. Even though you are dealing with young adults, they are often uninitiated in these procedures and there is no substitute for alert supervision. Again let me cite two cases:

A Wisconsin case in 1969 -- An adult student successfully recovered damages sustained when a grinding wheel disintegrated. The court found that instruction, maintenance, and supervision were all inadequate. Thus the instructor was determined to be negligent. The instructor had failed to properly instruct the student in how to use the machine and of the inherent dangers in its use; the instructor had not inspected the machine before it was used and had not enforced safety regulations. The doctrine of the deep pocket was applied to that citizen.

In California in 1931 a 17 year old student recovered a judgment for injuries sustained as a result of an explosion occurring in the classroom while the teacher was conducting an experiment with explosive gases. The court found that the teacher had failed to meet the duty required by one, failing to give proper instruction and two, failing to label and identify the materials to be used.

All I am saying is that if you want to protect yourself in the laboratory, you use reasonable simple prudence. You are all reasonable prudent people. The law does not say to you that you will be an insurer, that no accident will take place in the chemistry laboratory. They don't put that burden on you. They do ask you to act with simple ordinary care and to follow these simple steps:

Inform the student, maintain a relative safe place in which to conduct experiments, and provide appropriate supervision.

An Arizona Case 1968: The court denied recovery where the teacher had given instruction and was standing near by supervising the activity of other students and was not aware of or directing the particular activity that caused the accident. The teacher, the courts said is not required to be in all places at one time.

New York 1927: The teacher was not liable for a student that was conducting an experiment that was unauthorized and was being conducted without the knowledge of the instructor, although proper supervision was being maintained.

Florida: McGee vs Dade County Board of Public Instruction: The court stated that if a dangerous instrument is involved, in this case, scissors, and if the teacher authorizes use of or under the circumstances has reason to note that the instrument would be likely to cause injury, the teacher has the responsibility of close supervision as opposed to just being in the classroom.

The extent of supervision required is relative to the known dangers.

Now in this state our legislators, in their infinite wisdom, have provided a plan--indeed inacted statutes which authorize the boards of junior colleges to:

> Pay the attorney's fee to hire an attorney to represent a teacher who is charged with negligent conduct in the scope of that person's duties. Not only will they pay the court costs, but if a judgment is taken against a teacher, the board of trustees can, if they so chose, hold that person free of any damages assessed by a jury.

(So that is certainly very comforting to know.)

The law will not make you an insuror, but it does require of you the same ordinary care that should be exercised by persons that work in the laboratory.

Question: What about first aid, should we or shouldn't we?

Answer: We have that problem right now in our high schools, we have youngsters that will die from a bee sting unless they get care immediately. But the teachers say, "Suppose I go ahead and give this thing, I may do something wrong and the child dies, where am I there?" We have difficulty in getting persons who are willing to serve in and administers first aid? Nobody is going to hold you responsible for that--as long as you don't really botch it up. The only standard here again is, "Did you do what a reasonably prudent person is expected to do? Indeed, you as a chemist would be expected to give me an antidote if I poured the wrong liquid from a test tube down my throat.

Question: Is treatment without any sort of first aid course prudent?

Answer: Yes, that is prudent, you don't have to have a course before you can offer first aid. I haven't had first aid, but I have read that there are certain pressure points; so, if you get cut by flying glass, I would certainly try to stop your bleeding.

Question: What about insurance for the instructor at a school where they don't have the backing of the board of trustees. Is that available?

Answer: Yes, that is available. I would suggest first that you look at your homeowners policy for a few dollars you can get a rider on that ;olicy--if you are engaged in that type of activity. That is always the best thing to do. Don't look to the state because you know that in a case of really gross negligence the instructor comes in drunk and he is conducting some really gross experiments with gases or something like that you can't expect the board of trustees to come to your assistance. They will only help you to a point!

Comment: As a point, I have a rider on my policy for $100,000 and it costs $7/year.

Answer: You certainly want to look to that source of insurance and to what might be available from your teachers associations.

Comment: The Florida Association of Junior Colleges has a good policy: $50,000 for $5.00/year

Answer: Let me tell you that this is the finest money you will ever spend. You have got to go through one of these tortures one time before you can understand--somebody has got to be badly hurt and under your supervision--it's something that you have got to live through before you can really appreciate it. Another thing it's not inexpensive to defend one of these things even if you are found to be free of blame.

Question: If there is an accident in your lab when you are out, is that a non prudent type?

Answer: You have got to consider the circumstances. For instance, you have the keys to your laboratory. You walk out knowning that there are youngsters all about. You leave the door unlocked, is it not incomprehensible that someone might walk into your laboratory, open drawers, and even drink out of test tubes or what not. You have yourself a good law suit.

You don't have to remain in constant supervision over adults. More care is required the more dangerous the thing or experiment you are doing. I don't think a professor needs to be in the laboratory at all times. Again it really depends upon what is being done in there. What is standard?

Is there anyone who is constantly present in his laboratory? None of you is in constant attendance, so I take standard behavior means not requiring constant attention.

Question: But would a judge look upon it as being standard?

Answer: You can never tell what one will think. The answer would be, well, I'm going to call upon an expert--this gentleman right here: "I've been around this classroom for forty years and I never knew an instructor to stay in his laboratory"--that's good enough.

GENERAL CHEMISTRY

Loebel Helps Those Who Help Themselves

Arnold B. Loebel
Merritt College
Oakland, California 94619

Presented to a Concurrent Meeting of the Thirty-Eighth, Two-Year College Chemistry Conference, Pasadena City College, Pasadena, California, March 29, 1974.

Perhaps the greatest single cause for student failure or withdrawal from beginning college chemistry is inability to cope with simple mathematical problems. In an attempt to provide help along this line, we set up a course called Chemical Mathematics, which can be taken before or concurrently with General Chemistry. Initially, we attempted to structure this course in the normal lecture-recitation format, using several different workbooks at different times. However, it was found that the diversity of student backgrounds and the spread of their abilities made this procedure almost totally ineffective. Slower students were not able to keep abreast of more advanced students and, consequently, the attrition rate was at least as great as that in General Chemistry. Slowing the pace to accommodate slower students would have resulted in not covering sufficient material to support General Chemistry.

Therefore, in order to allow each student to work at his own pace, we instituted a totally auto-tutorial course. The results have been more than gratifying. Slower students lag considerably behind at the outset, but are able to catch up as the semester proceeds. Faster students may complete the course in as few as 10 weeks.

When it became obvious that there was no available programmed text, I wrote one which covers all the types of calculations that generally arise in the first semester of General Chemistry.[1] Since all of these problems lend themselves readily to an extremely simple dimensional analysis technique, this was the only procedure used for problem solving. The text is divided into 16 modules (chapters), each covering a separate topic. After a minimal mathematics review covering only exponential notation, the slide rule, and significant figures, the topics treated are: the metric system, percentages, density and specific gravity, mole concept, percent composition and simplest empirical formula, stoichiometry, gas laws, gas law stoichiometry, solution concentration, solution stoichiometry, colligative properties, and Faraday's Law calculations.

Preceding each module in the text is a Pretest, followed by the answers and a method of grading which directs the students to whichever section of the following program in the module they must work. Following the module is an extended Problem Set, immediately followed by the set-ups and answers to all the problems. Again, the student is given a grading procedure which indicates whether he is sufficiently prepared in the topic. If so, he is told to request a proficiency test on that module. If not, he is directed to return to the module and to work it through again.

When the student feels confident in a given module, he requests a proficiency test. If he passes this test, he proceeds to the next topic. If he does not, he is told to rework the module until he feels that he can pass it, at which time he takes another test. There is no limit to the number of times this test-taking may be repeated: however, experience has shown that even the slowest students require no more than three tries.

The course may be taken for one, two, or three credit units on a pass-or-fail basis only. The number of credits which a student receives depends on the number of proficiency tests he has successfully completed. We have found this type of course an excellent method of preparing the students; even the slowest student, if moderately motivated, will be able to achieve sufficient facility with calculations which formerly would have forced him out of General Chemistry.

---

[1] Loebel, A. Chemical Problem Solving by Dimensional Analysis. Houghton Mifflin Company, Boston, Mass. (1974)

Chemistry Approached with Work, Smart Pills and Love

Rod O'Connor
Texas A&M University
College Station, Texas 77840

Presented to a Concurrent Meeting of the Thirty-Eighth, Two-Year College Chemistry Conference, Pasadena City College, Pasadena, California, March 29, 1974.

First year chemistry has always been approached by many students with considerable trepidation. The subject seemed to be a tricky mixture of mathematics, memory work, and black magic. There was always so much material and the difficulties were compounded by the necessity for outguessing the professor to see if you could stumble on the "right" things to study (i.e., the ones that would show up on the exams). Yet in the fall of 1973, a new program was adopted in which more material was covered with 46% of the entering 2250 students earning A grades (89% or better performance). Student evaluations were very high and all indications were that both learning and student satisfaction were dramatically improving. The secret? Hard work, smart pills, and love!

The new program is called a Learning Systems Approach and it places the major responsibility on the student. The main idea of this system is to replace the student's reliance on "lecture notes" and "lucky guessing" by a carefully designed textbook which contains all the information needed in a framework of specific objectives, exercises, and self-tests. Exams cover only the specified concepts, information, and problem situations. Grades are based on announced performance levels (90% for A, 78% for B, 65% for C) so that the student knows that his work on assigned material and his review of any weakness revealed by self-tests can earn the grade desired. There is no "curve" to worry about and there are no surprises. Practice exams are used for final review and familiarization with possible question formats.

Another feature of the Learning Systems Approach is the recognition that students learn in different ways. Some require only the text. Others are helped better by lectures "hands-on" laboratory experiences, individualized "autotutorial" instruction, student self-help groups, or the opportunity to simply ask for professorial help when it's needed. To accomodate these varying needs, the System includes:

(a) Lectures on selected concepts and problem situations.
(b) Laboratory work which illustrates concepts or problems and which introduces the skills necessary for further chemical investigations.
(c) An Autotutorial Learning Center equipped with a variety of projectors, tape recorders, electronic calcu-

* O'Connor, Fundamentals of Chemistry: A Learning Systems Approach, Harper and Row, New York (1974)

lators, reference materials, and special study units utilizing motion picture, slide/tape, tape/workbook, and branched-programmed** formats.

(d) A student "self-help center" in a comfortable lounge where students can study together in a relaxed atmosphere and assist each other with concepts, problems, or laboratory reports.

(e) A Professor-Tutorial Program which provides 35 different hours per week in which senior faculty reserve office hours for students wishing to visit with them on an individual basis for help or simply to talk with "someone who cares".

(f) Weekly evening "review sessions" for students wishing more extensive group work on problem situations or examination topics.

The course is presented in fourteen lecture sections with uniformity and continuity maintained by the use of four semester exams and a final exam which are equivalent for all sections. Multiple-exams are prepared by devising two basic formats for each question. Then all questions are typed except for "variable sections" (e.g., numbers for mathematical problems or terms for concept problems), these masters are xeroxed, and specific information is added for each form (two unique forms per section). A random-number generation is used so that all multiple-choice answers have an equal probability (over all forms, not on a particular form), with the added requirement that no answers match for the two forms used within a section. Two practice exams are distributed so that students are familiarized with all possible question formats. They are instructed to complete their reviewing to their satisfaction, take one practice exam to identify areas needing a bit more work, review these as necessary, then take the second exam for practice under a 40 minute "time pressure".

What this system means to the student is that the faculty cares about him and will do everything possible to provide a variety of ways to help him learn the subject. It also means that the student must care enough to assume the responsibility of using whatever means necessary to learn the material. The system will work if the student works.

Because we recognize that a college science course, particularly one having thousands of students, is going to be somewhat traumatic for the new student and because we recognize that a student can work and learn better if he is not "up tight", we try to present chemistry with an informal and lighthearted style. For example, the introductory lecture before distribution of the package describing the Laerning System Approach may start with a "typical scare-technique". The students are warned of impending term papers, popquizzes, high failure rates, etc. When the expected "fear level" is reached, the professor says, "Now, if all this is not the absolute truth,

** O'Connor, Rod and John W. Hill, "Program Branching by Use of a Carousel Projector", J. Chem. Ed., 49, 138 (1972).

may I be struck by lightning!" The lights go out, there is a blinding flash, and the professor disappears in a puff of smoke! When he returns, he can tell the students what it's really going to be like and that's the last scare the working student will get.

Most new students do not really know how to study. We give them detailed suggestions for planning their study time for most efficient learning (see Fig. 1). Then, before an exam, smart pills are distributed (malted milk balls) with the announcement that, if taker as directed ("chew carefully and follow the study suggestions"), it is guaranteed that the student will be smart enough to do well on the exam.

Our system is not perfect and requires continuous efforts in feedback and revision. It also requires that the faculty work even harder than we expect the students to work. It is, for those of us involved in the teaching program, a true "labor of love". And once in awhile we ned some smart pills, too.

Figure 1

Section of Student "Study Suggestions"

Homework Assignments
Chemistry 102

We recognize that your time outside of class is limited and that it is important that you be able to utilize study time for maximum efficiency. We suggest, therefore, that you prepare a Study Calendar showing time blocks each day for each of your classes. Short blocks, about 30 minutes, are best, with a later time for any work not completed. For example, you might wish to reserve 7:30-8:00 pm daily for Chemistry, with "Chemistry Left-Overs" at 10:00-10:30. Alternate quantitative and non-quantitative courses (e.g. Chem, 7:30-8:00, English 8:00-8:30, Math 8:30-9:00, History 9:00-9:30) for most effective concentration.

For efficient learning in Chemistry, you should follow this sequence:

1. Before the lecture on a topic:
    a. Read the Unit Objectives* carefully
    b. Read through the Unit once.
2. Then attend the lecture and take notes.
3. First study time after the lecture:
    a. Skim through the Unit and your lecture notes briefly
    b. Study carefully Unit sections and examples pertaining to the required objectives.
    c. Work assigned Exercises.
    d. Try Self-Test questions corresponding to assigned Exercises.
4. If you have trouble with concepts or problems, see one of our Tutorial Professors as soon as possible. (If you can't work a problem in about 5 minutes, ask for help to avoid "wheel-spinning".)

5. <u>At the end of each week, review material carefully.</u>
6. When practice EXAMS are distributed, concentrate review on test areas. Use one practice EXAM to identify areas needing further study and the other practice EXAM as a timed self-test.

*NOTE: Text Objectives will be modified and changes will be announced in preceding lectures.

ASSIGNMENTS:

Assignment Number	Completion Date	Study Sequence
1	2/1/74	(a) Read UNIT 21 (b) Work Exercises 2-5 (c) Take the UNIT 21 Self-Test (1-5) (d) Read UNIT 24 (e) Work Exercises 2-5 (f) Take the UNIT 24 Self-Test (1-5) (g) Read UNIT 25 (h) Work Exercises 2-4 (i) Take the UNIT 25 Self-Test (1-4)
2	2/8/74	(a) Read UNIT 26 (b) Work Exercises 2-5 (c) Take the UNIT 26 Self-Test (1-5) (d) Review UNITS 21, 24, 25, 26 (e) Work the Practice EXAMS (#1)

Chemistry for Biologists

Kent Backart
Palomar College

Presented to the Symposium on Chemistry and Careers, Thirty-Eighth Two-Year College Chemistry Conference, Pasadena City College, Pasadena, California, March 29, 1974.

During the past five or ten years, you and I have read many articles devoted to the general chemistry course offered at the college level. I state that you have read these articles as I have, because you are not satisfied with the general chemistry course as it is now and you seek new ideas. That is why you and I are here. How unfortunate the others in our field do not feel this need and stay away from meetings such as this. I would like to quote from William Lippincott in the Chemical and Engineering News, April, 1969 as he states, "There is a nagging uncertainty about the effectiveness of the current undergraduate chemistry program, and for those who contemplate the consequences of a continuation of its present ebbing from success, this uncertainty changes ro concern." In the same article Lippincott states the results of a study between 1963 and 1968 which shows the percentage of baccalaureates in chemistry dropped from 2.0 percent to 1.6 percent of the total degrees awarded. This is a 20 percent declining line. At the same time all undergraduate students enrolled in chemistry declined the same amount. The following years showed a further decrease largely due to the unemployment picture in the physical science fields. All of this tends to indicate the disenchantment the student feels for the field of chemistry.

What are some of the reasons for this lack of excitement. I suggest that it might be the subject matter coverage. It is abstract, often difficult, irrelevant, and not practical or exciting to the beginner. Prior to 1957, the sciences devoted much time and space to what was called the social aspect of the sciences. Now it is seldom seen with the exception of such current saleable topics as pollution and environment. I contend that a general chemistry course can teach the necessary materials and techniques as well as relate to students' major field and simultaneously interest the student in the sciences, particularly in chemistry as a supportive field.

Chemistry isn't dull, we merely teach it that way. One possible reason for this is the textbook. How many of us teaching a course a particular way do so because the text is written that way. Isn't this an acknowledgment that the author has more insight into our particular class than we do. Or is it an acknowledgment that the author has a better sequence of presenting material than we are capable of. How much do we rely upon the prior training of the individual either through a high school or through a so-called remedial course at our own institution.

Of the students in the first semester general chemistry course, how many are declared majors in any physical science. How many in the life sciences or health related fields. How many take it for interest or as an elective. This could be of interest to us in planning our particular course, since so many teach general chemistry as though every student is a chemistry major. Richard Kokes in the mid 60's in an Advisory Council on College Chemistry publication stated that of one million students enrolled in high school chemistry-only one half would enter freshman chemistry. Of these, less than 2,000 would earn a Ph.D. in chemistry. This shows an attrition rate of

99.8%. Of chemistry majors that continue for a doctorate, only 2 out of 5 will earn that doctorate in chemistry. Why don't we as a profession look at these figures, or better still look at these students and teach the general chemistry course to the student that is enrolled.

Implementation of Chemistry for Biologists Course

After such a lengthy introduction as to why we should change our format of teaching general chemistry students, let me describe one such approach which has been implemented without serious difficulty.

1. Use a team teaching approach. The programs I have been involved with have used one person from the life science area and myself. The requirements are simple. Both must want to try the program , be flexible, and be willing to work a little harder. The method is a bit more time consuming, particularly the first time.
2. Scheduling. Each college must work out its own problems. At Palomar all that was necessary was an appropriate notation in the college bulletin stating that one particular section (listed by number) of the biology and the general chemistry courses had to be taken concurrently. Registration went smoothly with virtually no conflicts. The first day of the course the program was described to the students. They were told it was an experimental approach, the philosophy behind the course, and given an option to change to a traditional class at that time if they wished. None did. During the semester only 9% of the students dropped out as compared with the more typical figures of 20 to 30% in typical classes. The lectures were taught back to back for one and one half hours each on a Tuesday-Thursday schedule. The laboratories for the combined courses have been tried on a lengthy Tuesday-Thursday system as well as a Tuesday, Wednesday, Thursday schedule. The Tuesday-Thursday system appeared to work better. This schedule allows two full days with the students so that field studies may be incorporated with minimum difficulty. Extensive use of field studies created an enthusiasm for the course that the more traditional lecture room atmosphere never received.
3. Flexibility. The advantage as brought out earlier was the ability to utilize large blocks of time now normally available. By making arrangements with the team member, it was possible to utilize the double lecture session on occasion and this worked both ways. The laboratory sessions themselves were worth the extra effort.
4. Subject matter coverage. This was not drastically different from the more traditional approach. More problems and examples involving organic chemistry were introduced

into the course since they had direct application to the life science portion of the course. The life science instructor had a simpler time as he knew the chemistry, which was necessary was now being covered. This allowed more time for discussion on related topics both in chemistry and life science fields. There is not a topic traditionally covered in the non-biology oriented course that was not covered in this program. The only difference was the specific nature of the material which for the most part enhanced the interest. Normal respiration covers the gas laws, enzymes covers kinetics, fermentation can cover the aspects cf equations and stoichiometry. Individualized laboratory work fits well into this program.

The final criteria for judging this program was the success of the student. The attrition rate was remarkably low as mentioned before. The enthusiasm of the students was much greater than in many courses taught before and after on the traditional manner. Finally, the students appeared to have a better conceptual approach to the subject as well as improved factual knowledge. Follow up studies of these groups have indicated success throughout further educational programs. It is possible that the students were better prepared and also were superto other groups. However, there is no evidence to support this any more than there is evidence to refute our desired conclusion that the program itself created a better learning environment. If we read Schools Without Failure by Glaser, we can believe that it was the program that was successful. I challenge anyone to try this type of program, modified in many ways. The work is greater, but the rewards are worth it.

Structure and Bonding and other Institutional Aspects of Chemical Science

Leonard Fine
Housatonic Community College
Bridgeport, Connecticut 06608

Presented to the General Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, Canada, June 7, 1974.

In this short presentation, I would like to explore certain contentions concerning chemical education as it affects the liberal arts curriculum. As a part of whatever it is that constitutes "general education" for today's college students, one should consider the inclusion of some basic perception of the main themes of the natural sciences. Most particularly, that should include an introduction to Newton's laws and classical mechanics; quantum mechanics and the theory of relativity; the chemist's atomic theory should be included; genetic transcription and coding should be included; the ubiquitous nature of poly (everything), from ethylene and acrylonitrile to peptides and proteins; and so on through a frustratingly long list. The central problem to this kind of didactic enumeration is 'guaranteeing' that a high level of sophistication be provided to insure that the maximum end-product, the "educated" person, has attained a level of achievement in chemical science that is more than superficial.

These then seem to constitute a kind of collection of essential responsibilities. After all, can the underlying principles of the strangely fascinating quantum or the unique cleverness of the gene any longer be regarded as 'optional' for any person desiring to be considered as "educated"? Well perhaps no less so than the need for understanding the underlying principles of deficit spending, state and local government, the graduated income tax, and the joy of sex (not necessarily in that order). Whatever the particular bias or interest suggested by a student's indicated field of specialization, the student should receive science instruction at the limits of his capabilities.

But if all that seems already a too difficult task, it's still only half the job. If all it is we do for these students is present to them sophisticated science, we will have essentially failed most of them, for most will not continue on in the sciences. The problem here is that when we received our own training, we demanded nothing more from our introductory courses than GOOD science. But those among our students who do not intend to become <u>us</u> ...a point we often bury in the recesses of our pedagogic consciousness...want to be able to place science in the contexts of a <u>total</u> reality; they want to place science within the same frame of reference as other intellectual pursuits, perhaps in the contexts of a more realistic world view.

The nagging question then, is how should science courses contribute meaningfully to the general goals of education? And perhaps that question can be answered by making the following points. First, the young college student should have realistic expectations of being able to rationally proceed along the road to recognizing his own talents, whatever they may be. The science course, from its point of view, must be taxing and demanding of both student and instructor. There must be an ample opportunity for challenge, help, and evaluation in order to aid the discovery of ability...or lack of it. And at the end of this trial, both student and instructor should still be sane (or at least rational) about this whole science business. Second, within the short time span allowed for a course, enough substantive knowledge of a fundamental nature should be offered to convincingly demonstrate that the natural universe is reasonable and knowable. Essentially, considerable effort has to be directed toward making the student comfortable in the physical universe. Thirdly, the student should on occasion, be introduced to science as a social activity...which is hardly the image one ever gets from textbook chemistry, for example. The sciences offer a remarkable opportunity for illustrating the many roles individuals within a social group play as interpreters and transformers of human knowledge. Fourth, at the proper time and in the proper context, the student should be introduced to the history of science, it's scientific traiditon, it's characteristic patterns of growth, and perhaps most importantly, the unique way in which science anticipates the future. Fifth and finally, once in a while the student should be given the opportunity to think about the philosophical meaning of scientific knowledge. All too often the "generalist" takes away with him the view that philosophy in science is an unnecessary preoccupation, and all too often the student gets that view from his own instructor. Yet Aristotle, Newton, Einstein, and Bohr hardly felt that way.

Now what is painfully obvious is that these are not the "usual" goals built into the "usual science courses open to the novice. "Usual" courses fall into certain stereotypical classifications. There's the department's "workhouse special", designed for an audience expected to be professionals. This is the 'nuts and bolts' training course. It is right here that you learn how to scale mountain tops or derive the gas laws from the behavior of a particle in a box. And of all the courses, this is the one we really think we know how to teach. Well after that comes the watered down version of the "workhouse special", often taught with curious disinterest by this year's lose in the department lottery. Then there are the "of science" courses and the"and science" courses. These are the partnership courses with the other scholarly disciplines. And don't forget the "relevance" courses, which means superposition of any format that makes the subject immediately applicable. They're all O.K. if the science itself is understood.

So here then is the specific suggestion. One must build into our science courses the spirit and the substance of coherence. If we are to serve our students and ourselves best in the present, we must realistically prepare them for the future. That means we must not only be aware of the future, but must also have a firm grasp on the past.

A few connected episodes will be presented to illustrate these remarks. Each will touch upon some of the scientific, social, cultural, philosophical, and historical aspects necessary for exploring and developing coherent themes in chemical education. A number of unusual slides will be used to illustrate the talk.

THE INTEGRATION of LABORATORY WORK WITH TEACHING

The Role of the Laboratory in General Chemistry Teaching

Douglas Jardine
Capilano College
North Vancouver, British Columbia

Presented to the session on General Chemistry of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 7, 197 .

Most of the papers that we have heard over the past two days have been good in the sense that they have provoked our thinking through a description of what individual people or groups of people are doing and it becomes very clear to me that the process of instruction and thereby the processes of learning have been well looked after. Some people have gone highly technological, others have gone less technological, but nevertheless out of the furor of behavioral science of a few years ago, I think it has provoked the non-behaviorists to respond by better processes of instruction. And that is basically around the lecture part of the courses, I think, because the hobby horse that I think has to be ridden now is what are we going to do with the lab programs.

I think that they are now quite often in as bad shape as the whole instructional strategy of a course in general was five, ten years ago. As I see it, for too many first year students, chemistry labs are things that happen to them at a fixed time, once per week for about 14 weeks each term. Well, that isn't going to cover everybody because probably we've all been talking to the converted. But quite often that's the situation.

Now, it probably isn't that bad, you see, but even a cursory examination of any up-to-date lab manual will reveal the presence of relevant experiments. In fact, you'd be hard-pressed to find a lab manual that is published in the last four years that didn't salute the environmentalists. I dare say that there are lab manuals going to press even now that are really going to sock it to the energy crisis or non-renewable resources at large. Well, what's wrong with this, you want to ask. Or others are thinking, well, gee someone's really going to come back to the good old days of labs that we had when we went to college. Well, to this latter group that want to go back to the good old days, if there were, I must tell you now, that I'm not going to argue for a return to the tried and true and the classical experiments of first-year chem labs. And to the former group, my answer is, "Well, there is nothing wrong--nothing wrong with the topics at any rate." Unfortunately, even though the topics are withit, I have a lot of trouble again with the process. The relevancy of these topics are sadly diminished by the aseptic packaging of the lab manual, or the modular things you can buy and which, I can't help it, I've got to say it, I am bothered that they were so blatantly advertised at this conference. Now these things surely only serve to insulate the lab experience from the life to which the experience is meant to be applied. So what's my point? Well, that's very simple. When last did you review the role played by your laboratory program in the teaching of general chemistry? Well, we have an easy answer. Almost all of us can say it was last summer when I did that or if it wasn't last summer, better yet, it was last month. Well, we even put in one more relevant experiment. We've got a new NMR or a new black box and by golly, in they're going. We took out a couple of old dogs, you know, and we made editorial changes and students can read it better, spelling errors are gone and we really did review our lab manual and they're being printed out by the thousands for next year or next ten years or ---

Some of us didn't do that. We even purchased some of these canned things. And we did all that. But that's not my point. My point is, when last did we review the role played by our laboratory programs in the teaching of general chemistry?

Well, now I think maybe you are beginning to see my point, and regardless of when last you did it I invite us all to come through with me very quickly on reviewing your lab program right now. I want to ask you, "Now what is the purpose of the goal or objective of your lab program?" Is it to have the student learn and practice the scientific method or perhaps it's to illuminate and illustrate the lectures, or maybe still, it is to demonstrate chemical principles, or perhaps it is to have the student learn and develop certain laboratory skills. Maybe it's even to provide an historical perspective. You may have others. If that's the case, write them down. Once you put them down, you and your peers can find them at odd moments and kick them around and you don't have to rationalize that you have done all this before, you know it's a way up here. Get it down and review the blooming program. Why are you doing what you are doing? I'm not suggesting that it is wrong. Not suggesting that you ought to change anything. I'm suggesting that you ought to get out and review. From that point, it is.

So let's go back and consider this list. The items generally fall into two categories. Some of the purposes or objectives call for the lab role man to do something for, or to the student, while others of those that I mentioned call for the student to do something and that something was to learn. Well, come off it, you say, we all want the student to learn, and I agree. Therefore, I say, "Hey, let's state it, make it quite public," and the reason I say that is because I believe that we're all professionals and invariably we achieve our objectives and I'm convinced that if the purpose is to demonstrate chemical principles to students, the lab program -- now I'm not talking about the lab manual -- I'm now talking about the lab program -- the lab program that can demonstrate chemical principles will be significantly different from the lab program that you and I would design if the objectives were to have students learn those same principles. Now even if you consider that to be somewhat trivial, I think we can at least move on from an agreement of the purpose of what the lab ought to be to have students learn and you will have to fill in.

Well, what are we going to fill in? Do you want them to learn chemical history? Do you want them to learn chemical principles, laboratory skills, scientific methods. You know! I don't know. You have to do that. I can't do it for you nor can anyone else. It's got to be a reflection of you. I think we all want them to learn all these things. That would be my guess. We want them in fact, to learn and practice the scientific method and this is where some of us are going to part company, for I contend that learning the scientific method and learning to practice the scientific method is best done by a project of problem solving approach. Now that is to say, a student should be given or assigned a problem and then allowed to decide what it is they need to know and do in order to solve the problem. This approach recognizes the evidence which shows for the most students more is learned and learned faster if what is to be learned is based on a need to know rather than simply because I or you think it's nice to know, or perhaps even necessary to know. But if you can put it into a context of the student needing to know it, then they are going to learn best So the implication of this right away is that lab manuals have really got to be looked at seriously. I'm not suggesting that any of us have all of our students do a gravametric analysis in the 6th or 8th week of the term, I've forgotten which now, but they're therein, the temperature is all up and they're allheatin' the b'jeebers out of the crucible. Why? I don't know, it's something to do with barium or was it sulfate? I forget which way we set that lab up this year. Maybe your students aren't going to have to do a gravametric analysis this year at all. Is it really going to hurt them if none of your students have done a gravametric analysis? I'd be inclined to argue that other things taken into account, it wouldn't really matter that much.

Now I further contend that with this type of laboratory program chemical history, laboratory skills and chemical principles, will all be learned by the students. And I recognize that all students will not learn the same history nor the same skills or the same principles because the projects could well be different, you see. But they will have learned, and this is someone's, Ralph was talking about thunder being stolen; they will have learned how to learn, even if it is to learn those principles which are required for successful completion of the course. So in other words, they may be able to psyche you out even better than they have in the past. That won't hurt you. I will go so far as to say that the lecture program ought to be an off-shoot of the lab program. Right now it's the other way around, and we go through this terrible hastle trying to make the lab program match with the lectures.

By and large I think you're wasting your time, because invariable you're going to get out of step and the whole thing is going to crumble down and your basic assumption is going to be shown as false. It only has to happen once. So I think that the lecture program should be an off-shoot of the lab program. It would be foolish for me to try and argue that the project approach to a chemical lab is the only way to go and that's not what I'm trying to argue. I'm not sure you should let organic people into a lab just like that. I'm no organic chemist, but I've had my fair share of flash-backs and various things of that nature so you've got to watch safety. If you're at a large university and you've got numerous students, you know you've got another problem on your hands and I don't know how to solve those. What I'm trying to suggest to you that maybe we could take our collective blinkers off and rethink some of those things. Do we really have to do it quite the way that we are doing it now?

I do argue however, that it is a good strategy for learning the scientific method. That is, this project. Some people can approach chemistry through a historical model, but I have to approach it through the empirical route. If you want a glimmer of all the historical happenings for your students, assign or select a project for your students or have your students select a project and let them get a taste of what, historically, some of those people went through. It is particularly valuable to those students whose association with chemistry is an elective one. For those the elements of the scientific method will be learned, even though they may not necessarily have learned to practice the scientific method consistently. So, I'm urging you to review the role of the laboratory programs in your college and attempt to remove them from their second-class status. I recommend an article by Donald Clausson in a recent J. Chem. Ed. entitled "The Project Approach to Chemistry." The key thing that he puts forward in selecting a project is that you've got to search, look at the project as a potential for theoretical understandings, scientific understandings, technical understandings and chemical principles involved. You have to build into it an ease, a facility for the student with the library and you may have to conn the librarians into doing that sort of thing. You just can't leave them with their project, sink or swim, you've got to do these little things as well. The library personnel then, have to be in tune with you and your projects--not the chemistry person going off on his own.

What's the role of the instructor? The role of the instructor in this situation is one now more of a translator of technical terminology, so that they don't get bogged down in that. He suggests the scheduling of conferences with the students or groups of students. He suggests that copies of all your instructions to the students or notes of project sessions be kept. Sometimes students give report sessions to the class.

So, in conclusion then, let me say whether or not you adopt this project approach is not my point. I don't have an answer to the role of your laboratory. The adoption of the peoject approach is not nearly as important as the fact that you people reaffirm to yourselves the objectives for the role of your laboratory program in your college.

Two Experiments for an Eighteen Hundred Student First Year Laboratory

Elizabeth Leventhal
University of Toronto
Toronto, Ontario

Presented to a General Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 6, 1974.

In this paper, I would like to describe two experiments, mention features suitable to large classes of varying abilities and give the results and response of the class.

The first experiment is the synthesis of polystyrene by emulsion polymerization (1,2,3,4,5) followed by its molecular weight determination by viscometry (6,7,8). I will briefly describe the experiment and the techniques involved.

The reagents are weighed out on a triple balance. Portions of styrene were dispensed to restrict fumes and the total amount used. We ignored precautions such as a nitrogen atmosphere [1] although the mechanism is a chain reaction. Constant shaking and heating were required to form an emulsion. During reaction, a white coating appeared on the side of the flask. This subsided after about half an hour.

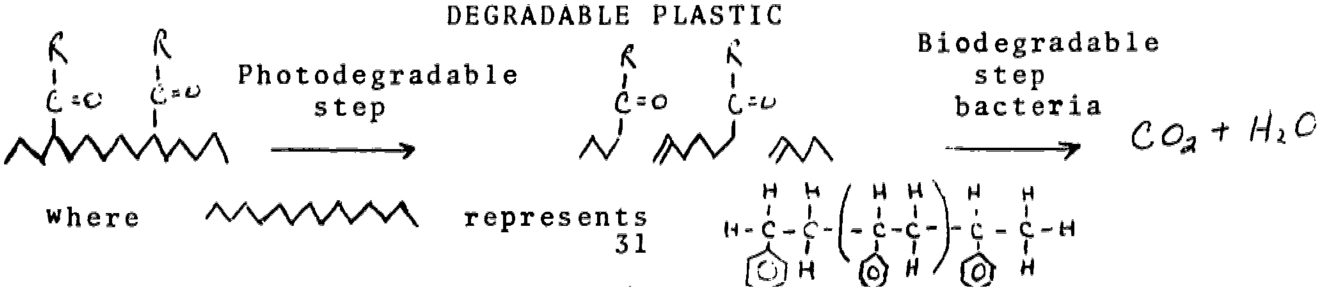
Salt was added to break the emulsion; the product was filtered by vaccuum filtration and air dried. The yield is about 75%. Its molecular weight was then determined.

An alternative was available for students who failed at the synthesis. Commercial polystyrene materials were provided to use as a substitute to continue the experiment without having to make up time in overcrowded labs. Also faster or more interested students were given the opportunity to do more work with these products.

The students were given a lecture on the relationship between molecular weight and properties. The articles made available were commercial styrofoam coffee cups and foamed photodegradable polystyrene materials including a sheet that had been exposed to UV light.

The degradable process was explained. The molecular

DEGRADABLE PLASTIC



weight decreases and the property change can be observed. The texture of the foamed polystyrene becomes brittle and powdery.

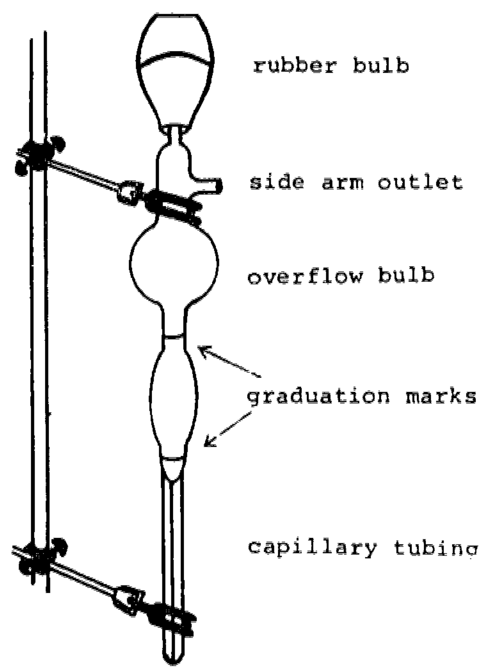
The response to this discussion was enthusiastic. As well as being related to a practical problem - a solution to litter - students felt that they were participating in a modern development - the research was actually being done in the department in Dr. Guillet's laboratory. The implication of an interdisciplinary field in the biodegradation step interested the students. At Toronto, research on this stage is being done at the Institute of Environmental Science and Engineering. Students were given samples of the photodegradable material to degrade at home and then measure the molecular weight.

For the molecular weight measurements the polystyrene sample was weighed out exactly, dissolved in toluene and filtered through cotton. An accurate concentration was made up in a volumetric flask.

A student proof viscometer was specially developed for this experiment (Figure 1). It needn't be dismantled in any way. The rubber bulb is compressed to draw up liquid through the capillary tubing - the side arm outlet is covered to control the flow. The side arm is also used to flush with toluene or acetone from a wash bottle in cleaning. The side arm was also made a convenient size so that vacuum tubing would just slip on in order to dry at the water aspirator.

Wash bottles containing toluene and acetone were provided for neighbouring students. For pure solvent measurements, the viscometer was rinsed with toluene through the side arm.

VISCOMETER



The viscometer was filled by compressing the bulb, covering the side arm, then slowly releasing the bulb. The upper clamp is then raised so the tip stays above the surface of the liquid. The flow was timed at the etched marks.

Before measuring solution flow times the viscometer is dried by first rinsing with acetone, then connecting to the water aspirator for a few minutes.

The intrinsic viscosity and molecular weight were then calculated from solution flow times.

CALCULATION OF AVERAGE MOLECULAR WEIGHT POLYSTYRENE

$$(n) = \frac{t - t_o}{t_o} \quad \frac{1}{C}$$

$$= \frac{(99.8 - 70.45)}{70.45} \times \frac{1}{1.0368} = .4018$$

$$(n) = KM^a$$

$$\text{Therefore } \log M = \frac{\log (n) - \log K}{a}$$

$$= \frac{(\bar{1}.6040 - \bar{4}.0414)}{.725}$$

$$= 4.9139$$

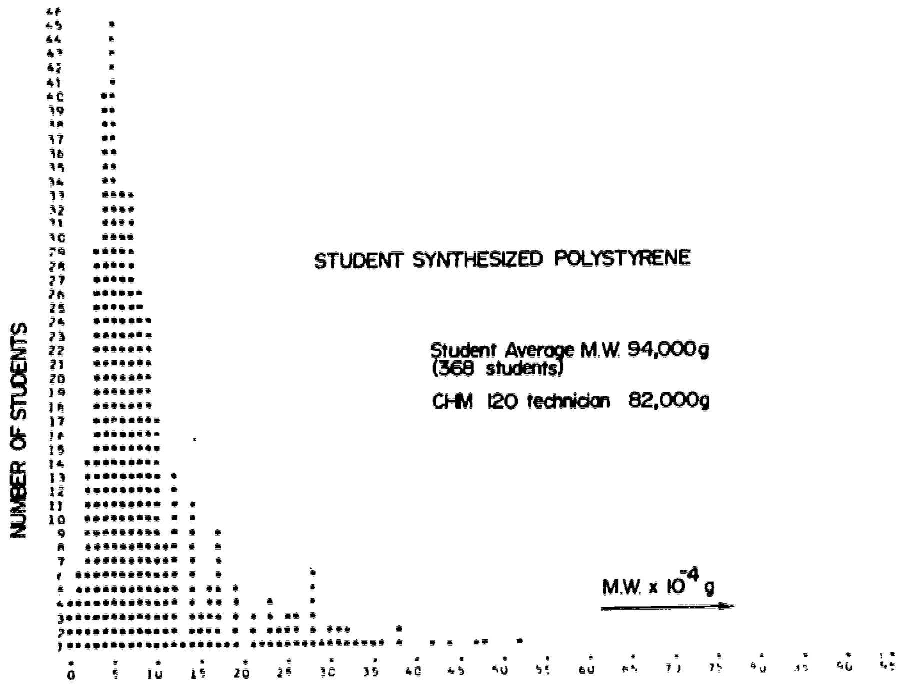
$$M = 92{,}020$$

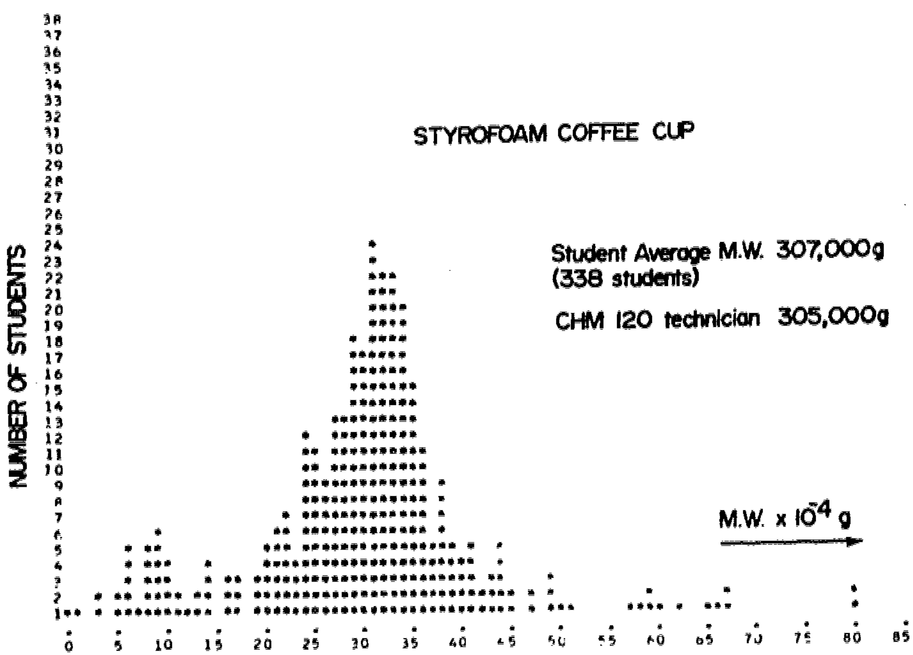
We have approximated in defining the intrinsic viscosity as we have and using it directly in the molecular weight calculations. This is a good approximation for linear polymers with concentrations of less than 1%. As a result our experimental molecular weights are several percent low.

The students made many numerical errors in this calculation - they found it difficult to deal with equations involving logs and this would be an area we would drill them in beforehand in the future.

We recalculated their data and the histogram (Figure 2) shows the results for their synthesized product, the student average molecular weight being 94,000 g with most students in the range 50,000 to 100,000. This is compared to our technician's typical value of 82,000 g.

The histogram for the coffee cup (Figure 3) shows values which are scattered between 250,000 and 400,000 with an average of 307,000 in good agreement with the technician's value. The students were required to hand in a data sheet (Table 1). The first two samples have just been discussed. A few of the students got through the photodegradable sample (the third row) with a value of 315,000 effectively the same as the technician's result.


STUDENT SYNTHESIZED POLYSTYRENE
Student Average M.W. 94,000g
(368 students)
CHM 120 technician 82,000g
NUMBER OF STUDENTS
M.W. x 10^{-4} g


STYROFOAM COFFEE CUP
Student Average M.W. 307,000g
(338 students)
CHM 120 technician 305,000g
NUMBER OF STUDENTS
M.W. x 10^{-4} g

44

DATA SHEET: Synthesis of Polystyrene and Determination of its Molecular Weight

Viscometer #___________

	SAMPLE	Wt polystyrene in 50 ml toluene (g)	Average flow time for toluene (to sec)	Average flow time for solution of polymer in toluene. (t sec)	M.W. polymer (g)
1.	Your Synthesized Polystyrene	.5184	70.45	99.8	82,000 94,000 (368 students)
2.	Styrofoam cup	.5609	85.65	194.4	305,000 307,000 (338 students)
3.	Photodegradable Polystyrene (Before Degradation)	.5038g	83.40	172.85	314,000 315,000 (6 students)
4.	Photodegradable Polystyrene (*After exposure to UV)	.5135 (overnight in sun simulator in Dr. Guillet's lab)	83.40	102.65	37,200 63,000 (3 students)

* Specify Conditions:

These samples were exposed to UV light overnight in a weatherometer. This was to be equivalent to two weeks of a Toronto summer and the molecular weight fell to 40,000-60,000 depending on exactly how long it was left there.

The second experiment deals with pollution - the analysis of detergents and lake and river water for phosphorus by the molybdenum blue method (9).

The students were told they could bring their own detergents or water samples. Only a few did this, but it did enable us to find those who were especially interested and encourage them or help them to be independent.

We used this as the first experiment of the year and one reason was to teach techniques such as the analytical balance when accuracy was not critical, since results were compared to results of Pollution Probe which has an accuracy of greater than 5%.

Another advantage for beginners was that a large supply of detergent was available if mistakes were made.

The students use a variety of common volumetric glassware making it easy for the entire class to do the experiment.

The first step in the phosphate analysis is the conversion of the phosphorus form to orthophosphate. Oxidizing agents are added and the sample heated to convert the sodium tripolyphosphate to orthophosphate.

Hydrolysis

$$P_3O_{10}^{5-} + 2H_3O^+ \rightarrow 3H_2PO_4^-$$

The second step is colorimetric determination of the orthophosphate. The solution was neutralized and transferred to a volumetric flask for colorimetric analysis.

To solve the logistics problem, each colorimeter was provided with the required reagents and syringe dispensers. First ammonium molybdate is added. The first reaction shows

Molybdenum blue formation

$$12\ MoO_4^{2-} + PO_4^{3-} + 24H^+ \rightarrow PMo_{12}O_{40}^{3-} + 12H_2O$$

ammonium molybdate — molybdophosphoric acid

$(NH_4)_6Mo_7O_{24}$

<u>Detergents</u>

$N_2H_5^+$

Aminonaphtholsulfonic acid

1-amino-2-naphthol-4-sulfonic acid (referred to as ANSA)

$$+ PMo_{12}O_{40}^{3-} \quad PMo_{12}O_{40}^{5-}$$

molybdenum blue

<u>Water Samples</u>

Sn^{+2}

Stannous chloride

the formation of molybdophosphoric acid.[10] The second reaction is the formation of molybdenum blue on addition of a reducing agent - aminonaphtholsulfonic acid in the case of detergents and $SnCl_2$ for river water.

The only chemistry we expected the students to understand was that the second reaction was slow. We expected them to realize that variables that affected this reaction would a-fect their results when compared with the calibration graph they were given (Figure 4). This is a plot of absorbance vs concentration phosphate of less than 30 mg/l PO_4^{3-}.

The aminonaphtholsulfonic acid was added and the timer started. After 5 minutes, a reading was taken.

CALCULATION OF % PO_4^{3-} IN DETERGENT (T(DE)

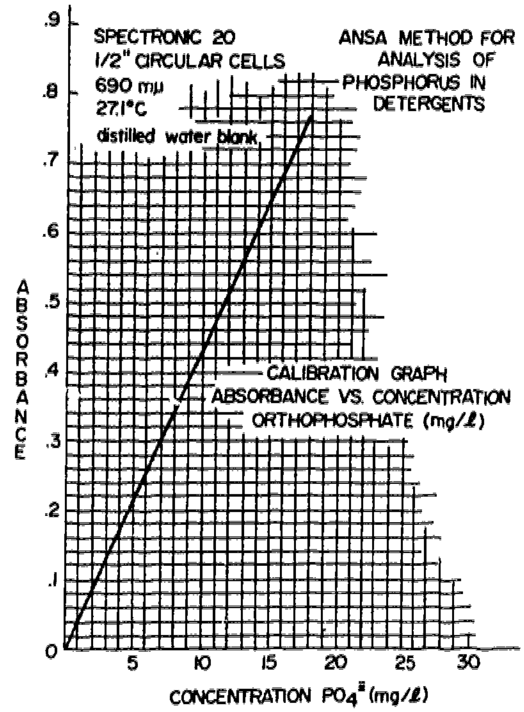
Absorbance A = .110 colorimeter reading

Concentration PO_4^{3-} = 2.50 mg/l
= 2.50×10^{-3} g/l from Calibration graph

Weight PO_4^{3-} in 1 liter flask = $50.0 \times 2.5 \times 10^{-3}$
= .125 g

Weight detergent in 1 liter flask = .429 g

Therefore % PO_4^{3-} in detergent = $\frac{.125}{.429} \times 100\%$
= 29.1%



The calculation involved determining the phosphate concentration in the analyzed sample from the calibration graph, converting that to the phosphate concentration in the detergent solution and calculating the percent phosphate in the weighed sample. The calculation was found to be difficult by many students. Conversion between moles and grams and calculating solution concentrations were difficult manipulations. Their background seemed very weak in this type of calculation and it may help to drill this vefore the experiment.

On the summary sheet, columns 4,5 and 6 (Table 2), one can see that the students' and the technician's results are within 4% of Pollution Probe's results.

The last column is a Tide sample analyzed in 1973 and the % PO_4^{3-} was found to be 6.6% compared to 29% in 1972 and 1971 and 43% in 1970.

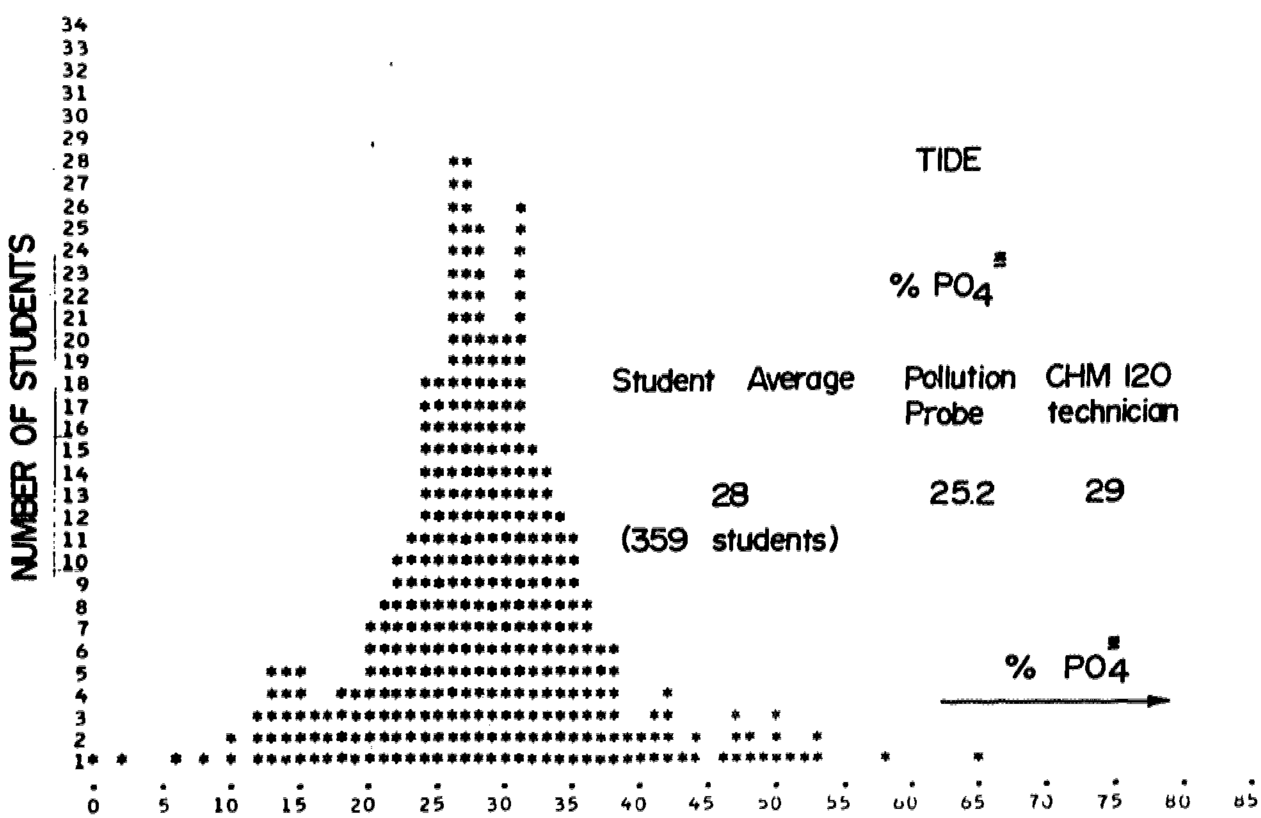
The molybdenum blue method has recently been found to be the most reliable method with the low phosphate detergents. In reformulating their products, silicate has been added and this interferes in other methods.

The histogram shows the number of students vs % phosphate for Tide (Figure 5). The students' average is 3% higher than that of Pollution Probe and most of the students are within 5% of this value. Fab, Bio-Ad and Domino-Blue were also analyzed with similar results.

Summary of phosphate (% $PO_4^{\equiv}$)

in Detergents

	Purchased Summer 1970		Purchased Summer 1971		Purchased Summer 1972		Purchased Feb. 1973
	Chem 120 Analysis July, 1970 Expt. performed Dec.1970 no student data available	Pollution Probe Release Feb. 9, 1970 Analysis performed in U. of T. Lab.	Chem 120 Analysis Feb. 15, 1972 Expt. performed March 1972 no student data available	Pollution Probe Release (1971) Analysis performed in Ottawa	Chem 120 Analysis June, 1971	Experiment performed Sept.1972 -student data	Pollution Probe no 1972 release CHM 120 Analysis Feb, 1973
Bio-Ad	49	49	25	-	25	29	
Domino Blue	31	32	30	27	31	28	
Tide	43	44	28	25	29	28	6.6%
Fab	30	36	30	24	27	28	



If the students had any questions or suggestions they were told to write to Environment Canada.

CHM 120 Students

If you would like information about the government plan to reduce PO_4^{3-} levels in detergents to 10% by weight (i.e. 5% P_2O_5) by January 1, 1973 or if you would like to express an opinion or suggestion regarding water pollution then write to:

Environment Canada,
OTTAWA, Ontario
Attn: Water Information Officer

The detergent method covered the basic techniques. Those students who wished to continue could go on to analyze water samples from natural sources for phosphorus content. Since the phosphorus concentrations were much lower, the experimental technique was more involved.

The water samples were kindly supplied by Dr. Jon Van Loon in collaboration with the Institute of Environmental Science and the Great Lakes Institute, University of Toronto.

A variety of samples were obtained - some from cottage country and rural areas and some from urban areas.

Sample bottles were labelled with both the location of their source and the date when collected because phosphate concentrations vary seasonally.

Lake Simcoe

Algae Polluted Beach
Sample taken Sept. 6, 1972, 10 ft. from shore. Algae have been filtered from this sample. In the late fall the algae die forming a fine brown filament which partially dissolves, releasing metabolized phosphorus. The result is phosphorus counts 100 times as high as this sample if analysis is performed a few months later.

Concentration P (mg/l)

Student Average	Institute of Environmental Science	CHM 120 technician
.16	.01	.06

For the river water samples stannous chloride reducing agent was used; it is less sensitive to metal ions in lake and river water. The time of reaction is 10 minutes. After the color develops at this point it begins to fade, due to the production of different molybdenum complexes and polymers. This is also the case with the method for detergents. Constant timing conditions are necessary.

In this case the reagents develop a color with distilled water alone so the instrument was first zeroed with a reagent blank.

Then the river water was analyzed over a concentration range of less than .5 mg/l of phosphorus (Figure 6).

CALCULATION OF CONCENTRATION PHOSPHORUS IN WATER SAMPLE

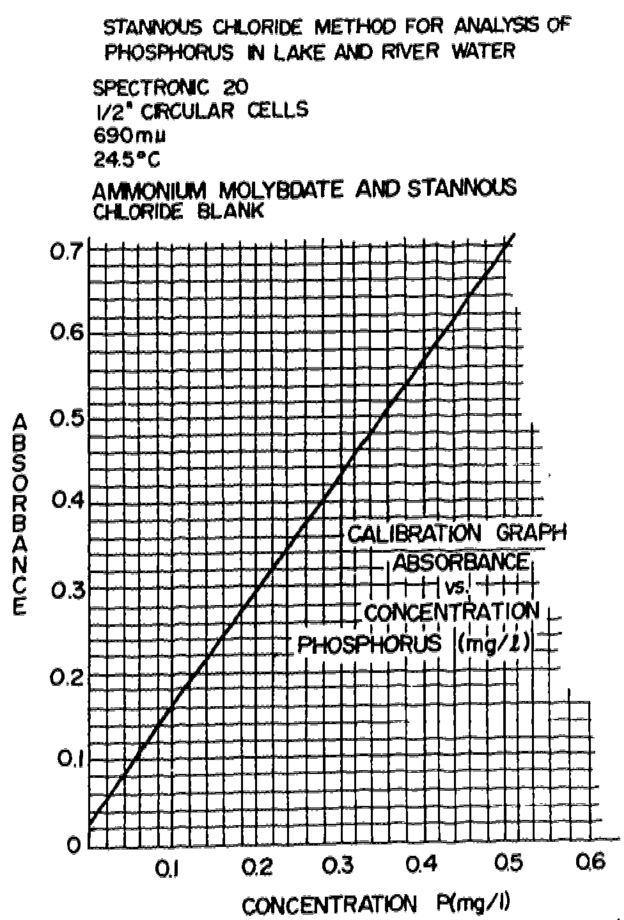
Absorbance A = .38 colorimeter reading

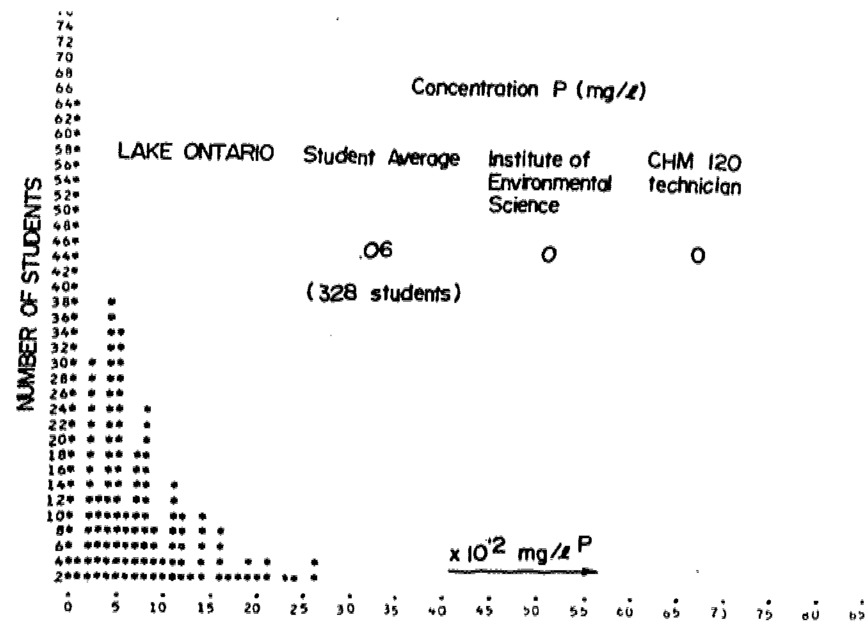
Concentration P mg/l = .26 from calibration graph

= concentration phosphorus in water sample taken.

The calculation involved determining the phosphorus concentration in the analyzed sample from the calibration graph and converting that to the concentration in the original sample.

Histograms of students' results were constructed for Lake Ontario (Figure 7), farm run-off into the Don River (West-Steeles and Dufferin), municipal sewage plant effluent into the Don River (East-Richmond Hill), discharge of Don River into Lake Ontario (Don River-Pottery Road).





The table (Table 3) shows that students obtained good agreement with the Institute of Environmental Science analysis. Our minimum detectable concentration was .01 within 66% confidence limits or .04 within 95% confidence.

Summary of Phosphorus Levels (as ppm P) in

Lake and River water

Site	Cause of Pollution	Institute of Environmental Science	September 1972 Sampling CHM 120 Analysis	Student Data
Lake Simcoe deep	municipal, farm, industrial waste	.02	.01	.05
Lake Simcoe shore	algae polluted beach	.01	.06	.16
Lake Simcoe shore	farm drainage ditch	-	.26	.37
Schomberg River	carries farm run-off to Lake Simcoe	.12	.15	.23
Holland River	carries industrial and municipal waste to Lake Simcoe	.23	.28	.26
Don River (East) Richmond Hill, Toronto	receives effluent from sewage plant	5.4	4.75	4.38
Don River (West) Steeles & Dufferin, Toronto	farm run-off	0 (<.008)	0	0
Don River (Pottery Road) East & West combined	municipal, farm, industrial waste deposited in Lake Ontario	.3	.2	.28
Lake Ontario deep	contents same as Toronto tap water	0 (<.008)	0	0

A summary of results on histograms was posted in the corridor outside the labs for student interest.

My impression is that experiments related to topical concerns stimulate students and are a means of gaining their interest in order to teach techniques and chemical principles.

In the phosphate analysis, techniques such as weighing, the use of volumetric glassware, the use of an instrument, the colorimeter were covered and in the polystyrene synthesis manipulation of glassware, vacuum filtration and the taking of precise measurements on a viscometer.

Chemical principles such as the theory of colorimetry was taught in the phosphate determination and in the polystyrene experiment the students were introduced to a synthesis and to a method for determining molecular weight commonly used for synthetic polymers and biological molecules.

The calculations involved moles, concentration and logs.

There was also flexibility in dealing with students of varying ability in that there were several stages in each experiment at which students could stop having completed a section of the experiment, or they could go on using a substitute material while more interested students could do extra work. A questionnaire covering these experiments as well as others done during the year was distributed in order to obtain students' opinions. About 80% of the comments were favorable. The students liked the fact that the experiments were topical. Where negative comments were made, they were mainly concerned with the difficulty in performing calculations. A few complained that the experiments did not parallel the lecture course.

Two comments which are indicative of the kind of favorable responses we obtained were:

> About the phosphate analysis:
>
> "I enjoyed doing the phosphate analysis of detergents and river water because they are things we hear about in the news. It is of interest to me to see how polluted the Don River is!"
>
> About the polymer:
>
> "The experiment interested me. I had nylon, polystyrene in my hand...the experiment felt rewarding!"

I would like to acknowledge Professors James Guillet and Jon Van Loon for valuable assistance and suggestions, Miss Helen Ohorondnyk for her valuable assistance, Mrs. Leslie Greenland and Mrs. Diana Bugeya who performed the experiments and Professor A.G. Brook and the Department of Chemistry for financial assistance.

REFERENCES

1. W.R. Sorensen and T.W. Campbell, Preparative Methods of Polymer Chemistry, Interscience, New York, (1968).
2. G.H. Coleman, S. Wawzonek and R.E. Buckels, Laboratory Manual of Organic Chemistry, Prentice-Hall, Englewood Cliffs, N.J., (1963).
3. M.M. Jones and J.W. Dawson, Laboratory Manual for Chemistry, Man and Society, W.B. Saunders, Philadelphia, (1972).
4. Symposium on Instruction in Polymer Chemistry, J. Chem. Ed., 36, 156-191 (1959).
5. Symposium on Polymer Chemistry, J. Chem. Ed., 42, 2-25 (1965).
6. K. Van Holde and R.A. Alberty, J. Chem. Ed., 26, 151 (1949).
7. F.W. Billmeyer, Textbook of Polymer Science, Wiley-Interscience, New York, (1962).
8. P.J. Flory, Principles of Polymer Chemistry, Cornell University Press, Ithaca, New York, (1953).
9. Standard Methods for the Examination of Water and Wastewater, American Public Health Association, New York, (12th ed. 1965 and 13th ed. 1971).
10. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Interscience, New York, (1966) p. 941.
11. Cleaning our Environment: The Chemical Basis for Action, American Chemical Society Report, Washington, D.C., (1969).
12. F.D. Snell and C.D. Snell, J. Chem. Ed., 35, 271, (1958).
13. J.R.. Mohrig, J. Chem. Ed., 49, 15 (1972).
14. F.A. Ferguson, Environ. Sci. Technol., 2, 188 (1968).
15. J.H. Ryther and W.M. Dunstan, Science, 171, 1008 (1971).
16. International Joint Commission Report on Pollution, 151 Slater Street, Ottawa, Ontario.

Taking the Laboratory into the Classroom—Armchair Experiments

Shahid Jalil
John Abbott College
STE Anne De Bellvue, Quebec

Presented to a General Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina Saskatchewan, June 6, 1974.

As you can see from my topic, armchair experiments are simply labs in the classroom. Perhaps most of the audience is already familiar with the concept of the Armchair Experiments, which was introduced by Professor Alyea at Princeton University, New Jersey.

Professor Alyea used these experiments mostly to replace the labs, especially for non-science majors, when the college or university did not have enough available lab facilities. In contrast, I have used these experiments as a teaching aid in the lecture. My aim in doing this was to facilitate a better, and clearer understanding of certain topics in chemistry, at the same time keeping the student interested and awake. As one student put it "Armchair Experiments are good because we are seeing what we are talking about." Students gain so much more by being involved in the experimental exercise in the classroom and they always look forward to the enjoyment of their work.

The whole idea started in summer '73, while I was teaching an Introductory Chemistry course. One girl asked me how do we know if all these reactions, which you taught today, really happen? I told her that we had done some of the reactions in our lab last week and that the remainder would be done next week. The girl laughed and said, "Oh yeah! Who remembers them?" Later on she confided that the main lab objective for most students was rapid completion with a minimum understanding of why we were mixing things together, what happens, when some sort of fizzling started in the test tube; or why we were pouring a solution from a long tube (meaning burette) into a container, or why we stop when the color appeared. Then she suggested the possibility of conducting classes in the laboratory. But of course, all lectures in the lab would not be possible. This incident suggested to me the possibility of Lab-Lecture integration as per Professor Alyea's Armchair Experiments. So consequently I initiated the use of armchair experiments in fall '73.

Armchair experiments are really quite easy to conduct, all you need is a small plastic tray, small size glassware (such as a small burette, small gas measuring tube, test tubes, etc.), hardware, a wash bottle, and a waste container (such as an empty plastic ice cream container). All chemicals were provided in containers suitable to conduct semi-micro experiments.

Coming back to my experience last winter, one of my colleagues, Dr. Barbara Hoewe, also became interested in these armchair experiments, and so we started doing them in our sections from the beginning of the spring. Students enjoyed it; they were doing, observing and learning all at the same time. Chemistry became something real to them. They were no longer sleepy, bored or yawning. There was something active for them to do. Since students worked in pairs, there was more communication among themselves and more relevant questions and better responses from the students, and even a friendlier student-teacher atmosphere. The beauty of these experiments is that while you are teaching about acid-base reactions you can stop and ask them to do certain reactions themselves;

i.e. acid with metal, or a carbonate, ammonium salt with a base. They can light a match and bring it to the mouth of the test tube and discover hydrogen for themselves.

While talking about solubility and precipitation reactions you can stop and let them predict whether a reaction will go to completion. It can be especially effective if you give them chemicals which will form colored precipitates and and solutions i.e., $NiCl_2$ + NaOH, or $Pb(NO_3)_3$ + NaI, $FeCl_3$ + NH_4OH, KOH + $CuSO_4$, etc. Students were soon able to write balanced chemical equations from a first-hand knowledge of the reaction, and also were able to write total and net ionic equations.

When they did the electrolysis of KI in agar solution, students were able to see a gas (H_2) evolving from one electrode and iodine depositing on the other electrode. Using this first-hand knowledge, they were able to write the half reactions, and were able to understand more clearly which species was oxidized and which was reduced. Among many of the other experiments, we included acid-base titration, electroplating and an experiment to illustrate Dalton's Law of Partial Pressure.

In addition, I did several interesting demonstrations using the TOPS kit, and used relevant displays on the lecture table to help illustrate and add interest to topics under consideration. I made extensive use of an overhead projector, with previously prepared transparencies, describing certain experiments step by step.

I have no intention of using these armchair experiments to replace the laboratory. The student, as usual, will go to the laboratory and do a series of experiments. However, since the students have already been exposed to the basic concepts and techniques through armchair experimentation, they will be able to use the time in lab more efficiently. This should free more lab time for individualized instruction. At the end of the course, I conducted a survey on the experiments in the classroom. 99% of the students responded that the armchair experiments were fun and interesting, kept them awake and alert, and gave them a better understanding of several topics. It also made chemistry more real and easier to visualize. Almost all of them preferred a course that included such experiments to standard teaching.

My ultimate objective is to modularize the chemistry course that I am teaching at John Abbott College and completely integrate it with armchair experiments. For that, my coworker, Dr. Hoewe and I have applied to the Provincial Ministry of Education in Quebec for a Research Grant.

I strongly recommend that you try these experiments in your class at least once to see their success and advantage over more conventional methods. Maybe I should not call these experiments Armchair Experiments, because we do not use chairs with arms, but instead small desks. Therefore, perhaps I should call them "Desk-Top-Experiments".

Instrumentation—The Horns of a Dilemma

C.G. Vlassis
Keystone Junior College
LaPlume, Pennsylvania

Presented to a General Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 6, 1974.

The Sputnik Age has come and gone, being followed most recently by the Moon Age, the Age of Color Television, the X-Rated Age, and the Age of Leisure. There seems to be some indication that the Age of Modern Civilization is rapidly drawing to a close. All one has to do is consider the riots and the murder reports in newspapers and the action pictures shown on television. Based on happenings around us, one might want to call this the Age of Fear, the Age of Anarchy, the Age of Streaking, the Age of Technology, or for the real pessimist, the Last Age.

In the realm of science teaching, we seem to be entering a new age, that of button-pushing and chart-reading. It is the time to fill the laboratories with instruments. It is the time to teach our students to push the buttons and to read the graphs relating to the number of buttons on the instrument. Is this age of instrumentation going to be a sensible and a useful age or are we leading our students down the primrose path with gadgetry?

Laboratory instruments lend a degree of automation to chemistry experiments and they are impressive showpieces, but do they belong in the laboratory courses of two-year colleges? Do push-button experiments do as much for the education of a two-year college student as they do for the vanity of the professor who just may want to show off for the visiting colleague?

The reason I decided to accept the invitation to present a paper at this very important meeting of chemistry professors was because of the opportunity- it afforded me to speak out about something which has been on my mind for several years.

I am concerned about the student of today and his ability to handle freshman chemistry courses which are serving a number of areas.

I am also concerned about the student who transfers from the two-year college and what, if any, built-in handicaps we will saddle him with by introducing instruments too early in his chemistry program.

And third, I wonder whether we are wasting precious funds on instrumentation and maintenance in view of today's economic crunch.

It must be made clear as I present some of my thoughts to you that because of the wide variety of two-year institutions and because of the many purposes of chemistry programs in the two-year colleges, my remarks might not be applicable to all chemistry courses. I am really concerned about what is happening to chemistry courses which are serving other areas and programs, that is, chemistry for science majors (biology, pre-medicine, dentistry, etc.) I also have some concern about courses designed for chemical technologists, the para-medical programs or other courses designed to prepare students for a two-year terminal program. Because of my concern I have called this paper "Instrumentation - The Horns of a Dilemma."

We are teaching young people more language at an earlier age, more mathematics in lower grades, and a breadth of science never before heard of in the elementary schools. By the time a student gets to high school, he is taking calculus, studying far more chemistry theory and more physics than many college freshmen (persons) received ten years ago.

Yet we also see the average IQ of college freshmen lower than it was ten years ago; we have seen the average student's reading ability going down every year for the past few years, and we have seen the verbal and math SAT scores on the average dropping over the past ten years.

When today's student, with the background just given, reaches college, we find too often that he is a poor reader, that he can't write well, that he doesn't know enough algebra (even though he has had calculus in high school), that he can't name chemical compounds and that he doesn't know basic principles of motion.

So instead of dealing with these problems, we might be compounding them by our philosophy of laboratory experimentation or our new age of instrumentation. We tell the student that we will save him time by having the laboratory assistant make the solutions in advance. We say to the student, "Don't worry about the math involved with the Spec 20, you'll get that later. Just push the buttons and clip the automatically recorded graph or computer printout to your lab report." We call this the age of "Specialization".

We are already moving from instruments to computers which are now being programmed to do in chemistry what the instruments are supposed to be doing. It is my premise that the future will continue to be one of greater specialization until we have the great majority of people dependent on a few "Specialists", somewhat akin to the age of specialization described in George Orwell's <u>1984</u>. We may be there already. Just listen to this list of topics which will be presented at the conference on computers in Chemical Education, which will be held at Queen's University campus, Kingston, Ontario, June 24-26.

> <u>The Use of Interactive APL Programs in Undergraduate Laboratories</u>
> <u>Logs, Antilogs, and Applications to pH-Concentration Problems</u>
> <u>Titration: A Laboratory Related Computer Assisted Learning Program</u>
> <u>The Use of Digital Computers in the Chemical Laboratory: CAI Comes Home</u>
> <u>Student Computer Use in High School Chemistry</u>

These are just a few titles. I am not saying that there is no place for computers in chemistry, but I get concerned when I read about the computer doing the medical diagnosis instead of the Doctor. You have seen the ad about the computer checking out your automobile, too.

Galen W. Ewing said "...You can cover more ground (with instruments) but you run the risk of losing touch...the instrumentation must always be the servant of chemistry." This was indicated to me by student comments about a laboratory manual:

"The lab manual was incomplete, ambiguous."
"The lab manual did not provide any help."
"The calculations were too difficult."
"Find a lab manual geared to us."

This is the age of visual learning, let there be no doubt about that. Young people are not reading, they are watching and because we are either not aware of that or because we are not concerned about that, we are falling into a trap - that of graduating a generation of "specialists" who don't know how or why, and worse, a generation of students who may not care.

The dilemma we face today is whether we should spend the time in the laboratory discussing the instrument, its operation and its applications to chemistry, or whether the time should be spent on more chemical principles needed to appreciate the instrument.

The photography professor at my institution told me he faces the same dilemma - should the student take a picture before he understand how a camera works or how a film is developed? In one case, the student will be a camera operator, in the other case he will be a photographer. It may be a fine distinction, but to me it is a very important distinction.

Every time I have the students using the Spec 20's, the pH meters, the Automatic Titrimeter, the IR, the AA, etc., I wonder what more should they know before they push those buttons. How are they going to learn "back titration" using the "dead stop" titrator? Do they know what an indicator is or how it works? Can they make a stock solution? Every time an instrument goes in (on top of shortened semesters), something comes out, and what comes out may be sound, basic theory and technique.

Let me just show you quickly some of the instruments which are available today and the percentage of two-year colleges which have them. These percentages are based on my questionnaire of a year ago with a response of 210 two-year colleges. Questionnaire responses is at the end of the article.

Some of you are now saying to yourselves, "This guy is probably still using the old two pan balances instead of the top-loaders. Everyone is using instruments today. What will happen to our students when they transfer if we don't let them have some 'Hands-on" time with our instruments?"

Several years ago at a meeting of this group on articulation between the two-year and the four-year colleges, I asked the group attending my session whether we would be shortchanging our students if they didn't have instrumentation. The answer then was mixed, but unquestionably more toward the need for the student who understands fundamentals and who has good lab technique than for those who can operate an atomic absorption spectrophotometer or a differential thermalyzer. They wanted students who could mix their own solutions. They wanted students who could do the calculations necessary for analysis.

Do they still want the same things today? In my estimation they do. But the surest way to find out is to ask those at the institutions which are taking your transfer students, "What do you want from us"?

One of our greatest handicaps has been a lack of articulation among teachers starting with the elementary - junior high groups and working right up to the undergraduate - graduate level.

Is there a solution to the dilemma? As just stated, articulation is a good start, but there are other things we can do if we are willing to make some sacrifices and if we are willing to face some facts about the classroom situation. We can't all have sections of chemistry filled with genius chemists with super high school backgrounds. Most college freshmen are average high school seniors with three months vacation. We cannot make the mistake of assuming too much about their background, their knowledge, their abilities, and their motivations. It seems more important to take the view that because the level of students entering freshmen chemistry classes is so varied, it is more important to cover ground which should have been covered somewhere else and sacrifice some things which can be covered at a later time. We should emphasize those principles, those concepts and those techniques which can be dealt with whether or not we have instruments available. Then the use of a particular instrument will support and strengthen the principles a student needs. We should emphasize something which is often neglected, that of teaching one how to be a student.

A student will not be handicapped when he comes across something unfamiliar or if he encounters an instrument new to him if he knows how to study, if he knows where to draw resource material, if he knows the value of self-discipline, and if he is well schooled in the fundamental principles of chemistry. He will be able to meet any challenge he faces when he leaves you.

I want to further emphasize that instruments should play a role in fortifying the principles of chemistry and in bringing to the laboratory an enthusiasm for scientific investigations. Actually handling equipment, such as a gas chromatograph, can excite a student even with no exposure to chemistry and perhaps he will be a better student because of his early exposure to instruments. In the end, however, every student should be able to say "I know how and I know why"! It is our job to make sure they can say both.

QUESTIONNAIRE RESPONSES

TYPE CATEGORY	% Any Available	Model Range S/I	Course Type
Colorimetric	61.9	2-5	1
Fluorometric	10.7	2-5	3
Nephelometric	7.5	15-20	1,3
Visible	57.9	5-10	1,3
Ultraviolet	28.8	5-10	3
IR	63.8	10-15	2
Flame	14.8	5-10	3
A.A.	14.8	10-15	3
N.M.R.	6.1	15-20	2
Mass Spectrometer	1.9	over 20	2,3
pH Meters	98.5	2-5	1
Titrators	21.6	5-10	3
Conductometric	10.4	5-10	3
Polarography	17.0	5-10	3
Electrodepositer	25.0	5-10	3
Two-Pan Balances	35.2	2-5	1
Single Pan Balance	88.0	2-5	1
Top Loaders	65.8	2-5	1
Electrobalance	30.5	2-5	1
Recorders	46.0	5-10	2
Melting Point Apparatus	61.3	5-10	2
Gas Chromatograph	62.2	5-10	2
Refractometers	40.9	5-10	2
Polarimeters	34.5	5-10	2
Electrophoresis	15.1	10-15	3
Counters	37.9	5-10	1
Electronic Calculator	29.3		
Programmable Calculator	20.5		
Mini-Computers	3.3		

Based on approximately 210 correct responses from Two-Year Colleges

S/I Student/Instrument ratio given as average size of section divided by number of instruments available.

1 = General Chemistry; 2 = Organic Chemistry ; 3 = Analytical Chemistry

A Modular Laboratory Program

Norman E. Griswold
Nebraska Wesleyan University
Lincoln, Nebraska 68504

Presented to a General Session of the Fortieth, Two-Year Eollege Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 6, 1974.

Some of you may interpret my title as a sales pitch for a specific modular laboratory program, but I assure you that my main purpose today is to consider, not so much the contents and mechanics of a particular program, but rather some thoughts concerning the design of such a system. For purposes of this talk, I shall use the term "modular laboratory experiment" to mean any self-contained individual experiment, whether it is written entirely for a local situation or for wide use through commercial distribution. It is true that I have written a number of modules so I will draw upon my experiences with these for examples.

First, I would like to review briefly some of the advantages and disadvantages of two common alternatives to laboratory instruction; this will not be an exhaustive list, but is included to provide an answer to the question of why we have adopted a modular approach. Then, I'd like to state some criteria that I tried to adhere to when I began designing modules for wide use. And finally, using a specific module to illustrate, I'd like to give a brief (and admittedly, somewhat utopian) description of the way we expect our modular system to work.

Perhaps I should begin with a few observations about the ways that I've seen laboratory instruction presented. There are a few teachers who give instructions verbally, expecting the student to remember it all without either seeing or participating. A number of teachers demonstrate important techniques, which is, of course better, but students may not grasp it all in one session and in larger groups, may not be able to see what is happening. Some teachers make students rely entirely on available operating manuals or on instructions given in lab manuals (the former is often in limited supply and is too detailed and the latter may not be detailed enough). This do-it-yourself method can lead to ultimate understanding for a student who is patient and who reads directions, but there are often not enough instruments to allow long learning times and impatient and non-reading students can cause this alternative to be pretty hard on instruments. Incidentally, I have seen these alternatives stated succinctly as:

If I hear, I forget
If I see, I remember
If I do, I understand

I'm sure it is clear than an appropriate combination of the above methods should work best in any approach.

A. TWO COMMON ALTERNATIVES TO LABORATORY INSTRUCTION:

Probably two of the most common methods of laboratory instruction are provided through laboratory manuals and modular experiments, although TV, movies, tape cassettes, and even computer systems are rapidly gaining ground.

1. Laboratory Manuals.

When I first came to my institution, laboratory manuals were used in general chemistry, so we were able to learn about some advantages and disadvantages of using them. There are a number of laboratory manuals available commercially, many of which are quite good. Some advantages of adopting manuals for the laboratory program include the following:

a. All experiments in one package
b. Experiments usually tested
c. Some text-manual "packages" are available

However, there are also some disadvantages in adopting laboratory manuals:

a. Limited choice
b. Too many experiments
c. Individual experiments not self-contained
d. Correlation with lecture difficult
e. Problems with revision
f. Bulkiness
g. Cost

At the time (early 1960's), we were underequipped and crowded so it was necessary to adapt the experiments in lab manuals to fit our situation. We were also unsatisfied with the choice of experiments available so we began writing our own about a decade ago. Thus, we entered the world of modular laboratory experiments.

2. Modular Laboratory Experiments

There are also advantages and disadvantages to be weighed in the use of modular systems. These can vary depending upon the type of modular system used.

a. Home-written experiments.

Some advantages of writing modules for local use only include the following.

a. Proper student level
b. Use available materials
c. Coordination with lecture
d. Regular revision possible

There are however, also some disadvantages.

a. Long preparation time
b. Distribution problems
c. Cost

One problem with home written modules is that, once you adopt an experiment for regular use, it still has to be prepared for each new class. This is likely to happen especially in the case of instruction in laboratory techniques. In the late 1960's, I had an opportunity to work with a group of people who thought it would be a good idea to make certain commonly-used experiments available commercially in modular form. The idea was quite unique at the time, so some special thought had to be given to the kind of writing to do. Virtually every chemistry course in the world includes instruction on certain basic laboratory techniques: safety precautions, weighing, measuring volumes, transferring chemicals, filtering, titrating, and using certain basic instruments such as pH meters and spectrophotometers. It was decided that my contribution would be in the form of a dozen modules with the general title of Laboratory Techniques. Now it* is possible to obtain a large number of modules commercially.

b. Commercially available modules.

Some advantages of using these include the following:

a. Experiments are pretested
b. Flexicility of choice
c. Modules are self-contained units
d. Regular revision possible
e. Reasonable cost
f. Distribution by bookstore

Naturally, there are also some disadvantages.

a. Adjustments to proper student level
b. Adjustments for available materials
c. Easy to lose

B. <u>CRITERIA FOR MODULAR EXPERIMENTS:</u>

As I began designing modules on experimental techniques, I gradually developed the following criteria (not necessarily in this order of importance):

1. Should teach important concept or skill
2. Should be self-contained unit
3. Non-routine work and quick results
4. Adaptable to various backgrounds
5. Employ common instruments and chemicals
6. Anticipate student questions and difficulties
7. Flexibility for different instruments
8. No unusual safety hazards

This is a confining set of criteria but, if a set of modules is to have any utility, it must be directed to the needs of the audience for which it is designed.

C. <u>USING A MODULAR LABORATORY PROGRAM</u>

Now let's look at one way to use these modules in a traditional system, employing as a specific example one of the modules with which I've been involved.

---

*Two well-known programs in the United States are:

a. Modular Laboratory Program in Chemistry published by Willard Grant Press, 20 Newbury Street, Boston, Mass. 02116
b. Laboratory Separates in Chemistry published by W.H. Freeman and Company, 660 Market Street, San Francisco, Calif. 94104

Each student has his own copy of the module and is expected to read it before the laboratory instruction occurs. By doing so, he learns the theory (why it works) and has his first exposure to the instructions themselves (how it works). The module contains diagrams of the instrument or apparatus so the student can gain some initial familiarity with the parts of the instrument, i.e., he starts with a close view of the instrument via the module. The initial reading of the module may cause questions to be raised in the student's mind and he can be on the lookout for answers to those questions when formal instruction is given by the instructor.

The student takes his module to the laboratory session (it's easy to carry) and if necessary, can refer to the diagrams and instructions in the module as the instructor demonstrates. Questions raised in the initial study can be answered answers can be written right on the module. Then the student tries the technique himself with his own copy of directions at hand as reinforcement to be sure he does not overlook a step. As he repeats the procedure and becomes more adept, his reliance on the printed module will become less and less until he is able to perform the technique properly without assistance. A student can be urged to save modules involving special instruction in certain commonly used techniques. Then, if a long time should elapse between his initial instruction and the next use, the student can refer back to the procedure part of the module again for a quick review.

Thus, if you have not already done so, I urge you to consider a modular approach to laboratory instruction; there are a number of advantages for doing so and there are a number of modules already available commercially to help you get started. If the modules are carefully designed and if students will actually make use of them a modular laboratory program can provide an effective, economical, and efficient method of laboratory instruction.

ALLIED HEALTH CHEMISTRY

Some Chemical Principles in Respiration Therapy

Karen Timberlake
Los Angeles Valley College

Presented to a Symposium on Chemistry and Careers at the Thirty-Eighth, Two-Year College Chemistry Conference, Pasadena City College, Pasadena, California, March 29, 1974.

In the next 24 hours, you will breathe about 20,000 times for you take 16-20 breaths every minute. Each breath consists of an inspiratory and expiratory effort. While you are involved in restful activity, you move a volume of about 500 ml, called your tidal volume, in and out of your lungs with each breath. During this 24 your period your body will require and take in during inspiration about 600 liters of oxygen and produce 480 liters of CO_2 to be expired. Large amounts of acid are produced in the blood stream with the dissolved CO_2, yet your blood buffering system allows only a change of a few one-hundredths of a pH unit in the blood pH.

The concepts of respiration include some chemical ideas such as the gas laws, concentrations, acid-base balance, buffers and pH. In my chemistry course for the health sciences, I have incorporated some concepts of respiration. This year, one-third of my class consisted of students in the respiration therapy program at Valley College. I also found that the nursing program treated many aspects of respiration and that those students in the biomedical technology program were working with blood gas analyzers. This situation motivated me to learn more of the chemical concepts utilized in the understanding of respiration.

The respiratory system involves the mouth, nasal passages, throat, trachea, bronchii, bronchioles and finally the tiny air sacs within the lungs called the alveoli, where the exchange of atmospheric and blood gases occurs. Secretions from the respiratory tract leading to the alveoli provide a saturated level of water vapor within the lungs. It is in the capillaries surrounding the alveoli that CO_2 is removed from the blood and oxygen added.

The principles of Boyles Law and diffusion of a gas according to a pressure gradient are essential in determining the direction of air movement during ventilation. Contraction of the diaphragm due to a signal from the respiratory center in the brain causes the expansion of the thoracic cage and thus an expansion of the lungs. The decrease in pressure (-2 to -6 torr) results in a flow of atmospheric air into the lungs until the pressures equilize. The relaxation of the diaphragm causes the pressure within the lungs to become greater than atmospheric (+6 torr) and so air in the lungs is pushed out until again pressures become equal.

Dalton's Law of Partial Pressures is of interest when comparing the gases in the atmosphere with the gases in the lungs. The contribution of water vapor, CO_2 and O_2 are of particular importance to the respiration therapist.

PARTIAL PRESSURE OF GASES: AIR AND LUNGS

GASES	AIR (DRY)	INSPIRED AIR	EXPIRED AIR	ALVEOLAR
O_2	159 mm Hg	149 mm Hg	116 mm Hg	100 mm Hg
CO_2	0	0	28	40
H_2O	0	47	47	47
N_2	601	564	569	573
	760 mm Hg	760 mm Hg	760 mm Hg	760 mm Hg

Henry's Law relates to the use of the term gas tension. The respiration therapist uses the partial pressure of the gas which would be in equilibrium with a certain dissolved quantity of gas in the blood. The term gas tension is used then in describing gases in solution such as blood gases in terms of their corresponding partial pressures.

PARTIAL PRESSURE OF BLOOD GASES: GAS TENSION (torr)

GAS	ARTERIAL	VENOUS	TISSUES
O_2	100	40	30
CO_2	40	46	50

These are the normal gas tensions to which a respiration therapist compares an arterial or venous blood gas sample.

The blood gas tensions also enable the student to understand the exchange of oxygen and carbon dioxide in the body. A gas dissolved in a fluid will diffuse from an area of higher tension to an area of lower tension or pressure. A partial pressure of oxygen of 100 torr in the alveoli, and an oxygen tension tension of 40 torr in the venous blood at the alveoli moves oxygen into the blood where 98% is picked up by the hemoglobin. At the tissues of the body, oxygen tension in the interstitial areas is about 60 torr and within the cell about 30 torr or even as low as 1 torr if the cell is quite active. Oxygen moves into the cells. The CO_2 tension is about 50 torr or greater in the tissues so CO_2 diffuses into the blood to be carried back to the lungs as venous blood where CO_2 can be removed.

LeChatlier's Principle and mass action effects can aid in the understanding of a model system of reversible association and dissociation of oxygen with hemoglobin as well as CO_2 combination with hemoglobin, and in the formation of carbonic acid. In this very basic model, a student can see that the greater level of CO_2 production will result in an increase of hydrogen ion concentration and a mass action effect upon this reversible system will cause more oxygen to dissociate.

LeChatlier's Principle in Respiration

Oxygen transport

$$HHb + O_2 \underset{\text{tissues}}{\overset{\text{lungs}}{\rightleftharpoons}} HbO_2^- + H^+$$

CO_2 transport

$$CO_2 + H_2O \underset{\text{lungs}}{\overset{\text{tissues}}{\rightleftharpoons}} H^+ + HCO_3^-$$

$$CO_2 + HHb \underset{\text{lungs}}{\overset{\text{tissues}}{\rightleftharpoons}} HHbCO_2$$

The respiration therapist is also concerned with the level of carbonic acid, bicarbonate and the blood pH which have these normal values in arterial blood.

Normal Blood Gas Values (arterial)

Pa_{CO_2}	40 torr	H_2CO_3	1.2 meq/liter
HCO_3^-	25 meq/liter	pH	7.4

The chemical concepts encounteres here involve acid-base principles and buffer systems. The Henderson-Hasselbalch equation illustrates the relationship of these components in the blood buffering system of carbonic acid and bicarbonate. The normal values for a blood gas sample will maintain a pH of 7.4. The body strives to maintain this pH even to the point of producing abnormal levels of carbonic acid and bicarbonate.

HENDERSON-HASSELBALCH EQUATION

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

$$K_a = \frac{[H^+][HCO_3^-]}{[H_2CO_3]} = 10^{-6.1}$$

$$pH = 6.1 = \log \frac{[HCO_3^-]}{[H_2CO_3]} = 7.4$$

Note that a pH of 7.4 is maintained as long as the HCO_3^-/H_2CO_3 value is 20: 1.

The control of the pH of the blood is through the lungs and the kidneys. Respiratory acidosis is a lowering of pH due to retention of CO_2. The compensating mechanism is through the kidneys which will seek to retain and increase the blood levels of bicarbonate. Respiratory alkalosis is an increase in pH due to hyperventilating or "blowing off" of too much CO_2. Metabolic acidosis is any condition other than respiratory which lowers the blood pH. The lungs try to compensate for this pH change by hyperventilating to remove some CO_2, so the pCO_2 will be lower than normal. Metabolic alkalosis is any condition other than respiratory which causes the blood pH to rise. The compensating mechanism is retnetion of CO_2 by the lungs by hypoventilation.

ACIDOSIS AND ALKALOSIS

lungs $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ kidneys

RESPIRATORY		METABOLIC	
Acidosis	Alkalosis	Acidosis	Alkalosis
$CO_2\uparrow$ pH $\downarrow$	$CO_2\downarrow$ pH $\uparrow$	pH $\downarrow$	pH $\uparrow$
COMPENSATION			
$HCO_3^-\uparrow$	$HCO_3^-\downarrow$	$CO_2\downarrow$ $HCO_3^-\downarrow$	$CO_2\uparrow$ $HCO_3^-\uparrow$
CAUSES			
hypoventilation	hyperventilation	kidney disease diabetes ingestion of acid loss of base (HCO_3^-)	kidney disease ingestion of base loss of acid (vomiting)

Respiratory therapy and concepts of respiration involve many chemical concepts and they can be combined to form a bridge so that students can relate to these chemical principles as they are encountered in the allied health careers.

Problems in Teaching Chemistry to Allied Health Students

Stanley Bah
St. Clair College
Windsor Ontario

Presented to a General Session of the Fortieth, Two-Year Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 7, 1974.

I would like to express my sincere appreciation for inviting me to attend this conference. I am very happy to be a part of this important discussion which will take place this afternoon. It is my intention today to give you some of the experiences which we encountered in teaching chemistry to allied health students. I would like to share <u>our</u> experiences with those you have, and exchange views or perhaps discuss some of the possible solutions.

With your permission, I would like to tell you something about St. Clair College in Windsor...

First of all, St. Clair College is one of the latest Community Colleges to be established in the Province of Ontario. The college is a middle-size one, and is divided into several schools, ours being the School of Health Sciences, offering the following programs:

Animal Health Technician Program	- 2 years
Bio-Science Technology Program	- 2 years
Medical Laboratory Technology	- 3 years
Dental Assisting Program	- 1 year

Diploma Nursing Program	- 2 years
Nursing Assistant Program	- 1 year
Pharmacy Assistant Program	- 1 year
Resident Counsellor, Mental Retardation Program	- 2 years

Now that you know a little about St. Clair, let us now turn our attention to the main topic of today's discussion "Problems in Teaching Chemistry to Allied Health Students."

There is no doubt in my mind that this is a broad topic, and it is impossible to cover the whole ramifications of this in one session because of the variety of problems involved which have direct bearing on the quality of teaching. We have therefore, to limit ourselves and our discussion, and concentrate only on a very few select areas that we identify as problems.

I am sure that you have been confronted during your career as a Chemistry teacher, with criticism expressed by a health practitioner that you do not understand the problems in health education. It is equally true that the chemistry teachers have expressed the opposite views - namely that health people do not understand chemistry because they never received the proper education and training in this field. And one can argue on and on endlessly without arriving at any conclusion. It seems to me that we have a two-fold problem on our hands

1. The Chemists are never told what specific courses in Chemistry to teach to health science students, and they are never given the course objectives by the health practitioners.

2. The Chemists usually have very little appreciation for Health Sciences in general, and tend to teach chemistry at a higher level than that required, and thereby frequently fail to make chemistry relevant to health sciences.

I personally believe that both claims are partially true. By saying this, I would like to give you some of my own ideas about health education. -

The trend in health education, as in all brahcnes of science, is toward more relevant knowledge. We feel that the teaching of health science students must be scientific, yet practical in order that students receive maximum benefit. It is an academic subject, imparting knowledge that would be useful to an individual preparing to be an informed and conscientious practitioner.

Health is an applied science that draws upon many fields, disciplines and areas. It is an ever-changing body of knowledge which must be kept up-to-date or ahead of the needs of the students. The material must be presented in such a manner that the student is able to understand it and explain the basic principles whenever needed.

From this description, I hope you realize that you are dealing with a special audience. Therefore, it is essential that the chemistry taught to these people must be tailored for the audience. Let us turn now to our main topic in identifying some areas which are creating problems in teaching -

PROBLEMS IN TEACHING CHEMISTRY TO ALLIED HEALTH STUDENTS

1. What should be taught?
2. Who should teach?
3. What level should be taught?
4. Role of administration.

1. WHAT SHOULD BE TAUGHT?

A. Set the objectives for each program based on a job description See Sample

B. Form a curriculum committee to include all disciplines in the program

C. Specialists to prepare detailed descriptions of courses comprising the program

D. Curriculum exmaination by specialists to integrate, coordinate, and co-relate content of program

E. Outline of clinical components by health professionals

THE MEDICAL LABORATORY TECHNOLOGIST

A Descriptive Analysis
of a
Recent Graduate

The Medical Laboratory Technologist in Ontario is a member of one of the largest groups of allied health workers whose primary place of practice is in the hospital clinical laboratory. His training encompasses two phases -- one didactic, one clinical. The didactic phase ensures that the student receives adequate theoretical material so that he may reach the required level of competence and be able to advance further in professional training and commitment. The clinical phase ensures that the student has adequate rotation through all areas of the laboratory with sufficient exposure in each, so that he may exhibit the following minimal standards.

He should:

A. (1) Be able to perform basic clinical laboratory procedures within defined limits of accuracy.

(2) Possess sufficient theoretical knowledge to learn to perform more complex procedures under supervision of personnel accountable for those procedures.

(Basic laboratory procedures are listed in Appendix A along with the defined limits of accuracy.)

B. (1) Be able to recognize and identify anomalous results due to:

(a) Technical errors
(b) Common equipment malfunction

(2) Be able, under supervision, to undertake corrective measures required for (a) and (b) above.

(3) Be able to assist in the implementation and development of new techniques or improvements to existing techniques.

C. Be able to recognize the results of a laboratory procecedure fall outside clinically established normal values, and to initiate appropriate action which may include reporting through established channels and carrying out additional related tests within established guidelines.

D. Be responsible for:

(1) Initiating the ordering of supplies essential for the performance of his assigned duties.

(2) Collating statistical information pertinent to his area of responsibility.

(3) Ensuring that the laboratory is kept in a safe, clean and orderly manner.

(4) Ensuring that laboratory equipment used in performing tests in Appendix A be kept clean, safe and operational.

E. Be knowledgable about and able to practice the ethics involved in dealing with hospital patients and related patient information.

F. Be able to communicate effectively with patients and hospital personnel.

The above is to be considered a minimum standard, and it is recognized that some graduates may exceed this standard.

2. WHO SHOULD TEACH?

A. Education part (concept and theories)
....Professional Chemists

B. Implementation of theory
....Health Professionals (Hospital employees)

C. A person whose qualifications embrace both theory and practical application

3. WHAT LEVEL SHOULD BE TAUGHT?

A. Each course should be taught at the level of competency required by the course objectives.

B. Ensure that level taught has direct relevance to practical application.

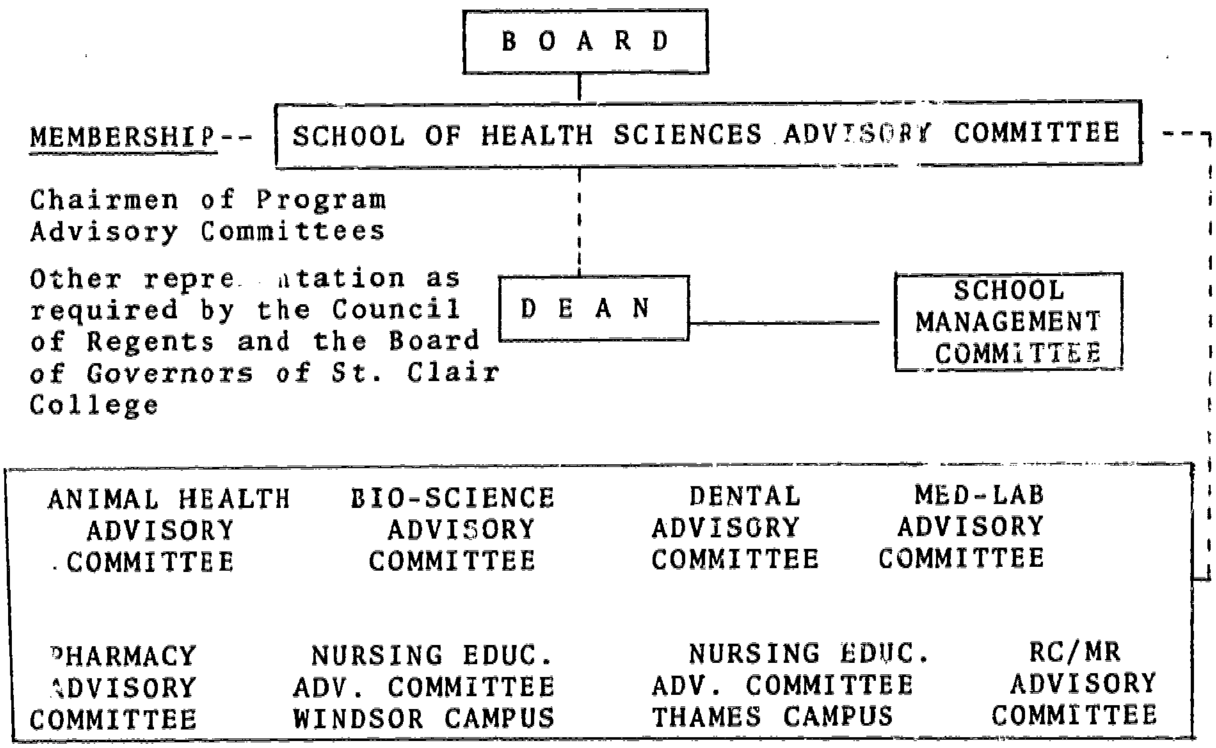
4. ROLE OF ADMINISTRATION

A. Provide an educational environment for the process of learning to take place.

B. Provide sufficient funds for the operation of Allied Health programs.

C. Establish Advisory Committees for each program. * See Sample.

D. Assist faculty in achieving their goals.



In conclusion, I would like to make the following remarks. If a Chemist really wants to be successful in teaching chemistry to allied health people, he should make an effort to understand the function and role of specific health disciplines. The best way of achieving this understanding is by spending some time, or working together in the same environment as the health practitioner, in order to acquaint himself with the important aspects of chemistry in a given professional discipline. Further, the chemist must participate actively on a Curriculum Committee, and be a member of the Advisory Committee. By attending these Committee meetings, the position of the chemist will be strengthened and respect and appreciation will automatically follow.

It is my conviction that the chemists alone can probably prepare a good chemistry program for allied health students. It is equally true that the health professionals are capable of developing a good chemistry program, (perhaps slanting more toward the practical application). The only real solution lies in having both professions work together to prepare a relevant program in Chemistry that would be meaningful to the student in an allied health program.

Valence or Relevance

George I. Sackheim
University of Illinois
Chicago, Illinois

Presented to a Concurrent Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 7, 1974.

How do we get students interested in chemistry? How do we make them see that chemistry is relevant to their chosen profession? I believe that one answer to these questions is that we must be more than just a chemistry teacher. We must show the students that we know something about the areas they are getting into and can relate to those areas. I have my own system for interesting my nursing students in chemistry, but it is a rather unique circumstance that applies only to me. I preface my introductory remarks with the statement, "While some of the material you will be given may not seem important or relevant now, it will all be useful at some time during your education in the nursing profession. In addition, you will all have to take the National League for Nursing Chemistry Examination and since I wrote it, I feel that I know what areas of chemistry you need".

Chemistry for the Health Sciences has undergone considerable change in the past few years, not particularly in content, but more importantly in the emphasis on direct medical applications. Students in the health science fields - nurses, technicians, etc., no longer perform tedious laboratory procedures. These are done by sophisticated machines. What the students need to know is the interpretation of those results and what might be done to correct any irregularities found. In addition, they must be shown that chemistry is not an isolated subject area, but can (and must) be integrated into many areas of the health field.

To give you just a few examples of the relevant materials in some areas: We all teach, or assume, that the students are familiar with the metric system. But, instead of asking a student to calculate his or her weight in kilograms, how much more meaningful is it to ask the student to calculate the amount of medication she must give if it is prescribed in terms of mg/kg body weight. Likewise, instead of asking for the area of an object in cm^2, why not relate this concept to the fact that the body loses a certain number of calories per square centimeter of body surface area.

Do we teach the relationship between different units of volume? Do the students have any idea of what a mm^3 is and how its size compares to a cm^3? If we mention the fact that there are 5 million red blood cells in a mm^3 of blood, then perhaps they will get an idea of relative sizes of volume units as well as cell sizes.

When we talk about elements in the human body, do we mention in addition to C, H, O and N, those which are necessary as trace elements and where they perform their function? Do we explain why some elements are poisonous and why? Do we help eliminate some of the older myths such as the fact that arsenic is poisonous? Actually, it is not. You could eat a handful of arsenic powder with no effect upon the body. It is arsenic compounds that are the poisonous substances. Do we mention the fact that barium compounds are poisonous and yet we use barium sulfate for x-rays. Isn't this a good place to mention something about solubilities?

Somehow the topic, rates of reactions, is deemed too complex to be taught to students in the health sciences. But how about including it in relation to hypothermia and open heart and brain surgery? Also, what about the rates of the body's reactions during a high fever?

We cannot talk about the energy requirements of the body without stressing the chemistry of ATP. You probably have been doing so, but how about adding the role of cyclic-AMP, a substance whose role in the body has far reaching consequences in the conversion of glycogen to glucose, in the conversion of fats to fatty acids and glycerol, as well as in the regulation of enzyme activity within the cells.

While chemistry courses discuss osmosis and diffusion, how much more meaningful is it in terms of hemodialysis, the use of an artificial kidney machine. Topics which can be discussed are the removal of waste products, the addition of nutrients to the blood, the effects of the presence of various minerals in the dialysate, etc. For example, we can mention the fact that if the dialysate water is not properly regulated in terms of its Ca/Mg content, 50% of the patients using the machine will develop metabolic bone disease. We all mention something about the need for isotonic solutions during transfusions and indicate the problems involved with the use of either hypotonic or hypertonic solutions. All of this can be related directly to osmosis and diffusion. But what about the fact that the concentration of K ions in the intracellular fluid is so much higher than that in the extracellular fluid while the reverse is true for Na ions. Why aren't these difference in concentrations equalized by diffusion and osmosis?

Here we can mention the topic of active transport, a system of reverse diffusion, and indicate something about the accompanying energy requirements of that system. We can also give them an idea of the importance of these ion concentrations by mentioning something about the effects of digitalis on the heart being accompanied by a shift in the concentrations of these ions.

The gas laws are an old standby in chemistry courses, but how much more meaningful is it if we discuss partial pressure of O_2 and CO_2 in relation to their movement into and out of the blood stream. Additional topics that can be covered at the same time are the use of oxygen in oxygen tents, what effect an increased partial pressure has, why moisture must be added to the oxygen; why too high an oxygen concentration can cause blindness in a newborn infant, why oxygen under high pressure is useful in the treatment of some types of cancer, why and how we add various drugs to the inspired air and so relate to the area of inhalation therapy. Why shouldn't we, at the same time, say something about pollution and pollutants?

We can mention something about the rate of O_2 and CO_2 exchange in terms of the rate of blood flow through the capillaries. We can also mention the topic of chemical analysis of blood for the presence or absence of various constituents. We may also mention the clinical symptons of hyperkalemia, hypokalemia, hypernatremia, hyponatremia, etc.

Oxidation-reduction is another topic always discussed in chemistry courses. We ask our students to balance complex chemical equations without giving them any idea at all as to what these reactions mean and where they might be useful. While the oxidation-reduction reactions in the body are not simple, they may be explained in terms of the loss or gains of oxygen and hydrogen, instead of merely saying that oxidation-reduction takes place in the cells. Isn't it more meaningful to explain these reactions in terms of electron donors and receivers in the mitochondria? Then we can relate this topic to the body's energy requirements and to the Kreb's Cycle.

Radioactivity is always a topic of great interest to students in the health sciences. But it is not enough to talk about radiation as a theoretical subject. Our students want to know the latest information about the newest radioisotopes, what they are used for, what precautions must be taken in handling them, how the radiation can be measured, what effects the radioactive material will have not only upon the patient, but also upon the student. It is surpising to note how many students believe that there is residual radiation present in the x-ray table after a patient has used it. We might also mention normal background radiation always present and what effects it has on life expectancy.

Of utmost importance in the body's metabolism is the regulation of fluids and electrolytes. We should teach them what electrolytes are, how they are regulated, and particularly what effects will be produced by an excess, deficiency, or sudden shift of these electrolytes. Terms we as chemists should not be afraid to use are metabolic acidosis, metabolic alkalosis, respiratory acidosis, and respiratory alkalosis. Obviously our students are taught pH and hopefully something about its control by buffer systems in the body. But what happens when something interfers with these control systems?

We may mention the topic of water, its properties, purification, and production in the body during metabolism. But couldn't we also explain why the body needs so much more water when the person has been taking sulfa drugs? Isn't this a good place to stress the topic of solubility?

Drugs are another important part of a chemistry course relating to the health sciences. But just to mention drugs and to state their formulas and effects is not enough. We should also mention something about their action in terms of their structure so that the students can see why certain drugs inhibit specific reactions. We can also mention whole families of drugs, such as the sulfa drugs, and show how they are all related to a parent compound. We should also mention the topic of drug interactions, where two drugs, not particularly harmful or possibly even beneficial by themselves, can produce a toxic reaction when taken together. For example, carbon tetrachloride fumes are toxic to the body, but unless large amounts are inhaled, the results are not too severe or long lasting. But if CCl_4 fumes are inhaled (as with the use of some older types of cleaning fluids), and at the same time, the person has taken two drinks of an alcoholic beverage, then death will occur within 6 hours.

How much time do we devote to DNA and RNA? Is this all to be left to the biologists or can we help out students understand the chemistry involved here, particularly in terms of the types of bonds and the energy required to break those bonds?

We can mention the fact that LSD breaks chromosomes and also mention the possible genetic damage to future generations. But is this the only chemical that breaks chromosomes? How about caffeine? It also breaks chromosomes, but not to as great an extent. Is it dangerous?

Do we remain in the chemistry area or do we refer to other areas that the student is involved in? If we talk about pollution, might not we also mention something about contamination of foods, medicines, surgical instruments, etc. How far is chemistry removed from the subject of nutrition? To bring out another area which students seem to find quite upsetting - how often I have corrected my students papers in terms of grammar and spelling only to hear them complain, "What does English have to do with chemistry?"

So, my point is that in teaching chemistry for the health sciences, we must strive to keep our material relevant and as up-to-date as possible. We know that biology teachers have to include chemistry in their courses. Should we as chemists include relevant material from other areas?

Specialized Chemistry for Physiotherapy and Radiography Students

Neil Cameron
Mohawk College
Hamilton, Ontario

Presented to a Concurrent Session of the Fortieth, Two-Year College Conference, University of Saskatchewan, Regina, Saskatchewan, June 7, 1974.

Physiotherapy is the science and art of assessing and treating persons afflicted with ill health, disease or physical handicap.

How is chemistry involved in physiotherapy and radiography? One of the reasons cited for the study of chemistry by paramedical students is that chemistry should serve as a background to the study of such related fields as microbiology, medical laboratory technology and other paramedical disciplines.

At Mohawk, physiotherapy students pursue a general chemistry course, - Life Science I - in the first semester of the first year of the three year program, followed by a course in physiological chemistry - Life Science II - in the second semester. Radiography students, also take a general chemistry course - Life Chemistry I - in the first semester, followed by Life Chemistry II, a course in physiological chemistry in the second semester.

How can the general chemistry course be structured to optimize the students subsequent experiences in physiological chemistry - physiotheraphy and radiography. The general chemistry courses (life Chemistry I and Life Science I) offered at Mohawk provide a background in basic chemical theory with special emphasis on those concepts that are relevant to physiotherapy and radiography. The physicochemical concepts which have immediate application in the field of physiological chemistry and eventually physiotherapy and/or radiography are:

(1) Acids, bases, salts and electrolytes- as related to acid/base balance and electrolyte balance in the body.

(2) Gas Laws - Dalton's Law of Particl Pressures, Henry's Law, Boyles Law, as related to respiration.

(3) Oxidation - Reduction as related to biological oxidation-reduction reactions taking place in the body.

(4) Solutions-for understanding the solvent action involved in digestion.

(5) Colloids - for understanding the particular nature and properties of proteins, amino acids, and nucleic acids.

(6) Covalent compounds - as related to the types of bonds that must be broken and rearranged as in the formation of high energy phosphate bond.

(7) Emulsions - for understanding the need for emulsification of fats before digestion.

(8) Nuclear chemistry and radioactivity for understanding the biological effects of radiation on cells and organs; - particularly for dariography students.

(9) Contrast media - eg. $BaSO_4$ used in digestive tract radiographs and iodine compounds.

What answer do you give to a student of physiotherapy in response to the questions, "Why do I need to study chemistry?". It seems to me that the best result i.e. satisfying the student, and possibly motivating the student, is obtained if the direct relevance between a physico-chemical principle and an important aspect of physiotherapy can be shown. Let us consider the Gas Laws and Respiration.

Respiration is of paramount importance for the physiotherapist. Respiration involves the four following stages:

(a) Pulmonary ventilation - the actual inflow and outflow of air between the atmosphere and alveoli.

(b) Diffusion of oxygen and carbon dioxide between the alveoli and the blood.

(c) Transport of oxygen and carbon dioxide in the blood and body fluids to and from the cells.

(d) Regulation of ventilation and other aspects of ventilation.

The diagnosis and treatment of most respiratory disorders have come to depend on an understanding of the basic physiological principles involved. Some respiratory diseases result from inadequate ventilation, while others result from abnormalities of diffusion through pulmonary membranes, or of transport from the lungs to the tissues. The physiotherapist, in treating such patients, try to increase pulmonary activity, which in effect increases the lung capacity for the intake of a greater quantity of oxygen. Thus, during therapeutic exercises, the oxygenation of the blood is increased, not only by alveolar ventilation, but also by a greater capacity of the respiratory membrane for transmitting oxygen into the blood. A thorough understanding of respiratory physiology entails many basic principles of gases, such as Henry's Law - to understand the dissolution of oxygen in alveoli liquid and in plasma; Dalton's Law of Partial Pressures - to understand diffusion from the alveoli to the pulmonary blood, for it is the partial pressure of the gas that determines the force it exerts in attempting to diffuse through the pulmonary membrane.

Although direct relevance of certain physico-chemical principles to physiotherapy is evident from the above example, the course in physiological chemistry - Life Science II - emphasize the organic/physiological principles. Students planning to enter any career concerned with health care should have a background in chemistry in the areas that are directly related to normal/pathological principles. While biochemical reactions are complicated and require an extensive background for a complete understanding, the student should gain some appreciation of the kinds of reactions and their importance to physiotherapy.

The following pages give an outline of the major topics covered in the Life Science II course offered to physiotherapy students at Mohawk College.

Where appropriate, some topics are considered simultaneously with a relevant topic in the Human Biology course.

A. Forces Producing Movement of Substances Between Body Compartments

The difference in concentration of ions, Na^+, K^+, Cl^-, $PO_4^{\equiv}$, etc., between the extracellular body fluid and the intracellular fluid is extremely important to the life of the cell. It is important to know how these differences are brought about by the transport mechanisms in the cell membrane.

1. Diffusion

   a. Magnitude of diffusing tendency,
      - concentration (chemical) gradient
      - electrical gradient with respect to the movement of ions
      - pressure gradient, e.g. diffusion of water across red cell membrane.

2. Donnan Effect

3. Solvent drag

4. Filtration

5. Osmosis, osmotic pressure, osmolal concentration

The above processes are passive processes in the sense that they require no energy input.

There are many instances in the body in which the ions or other substances are transferred "uphill" against concentration, osmotic, pressure, and electrical gradients. Such movement is called active transport.

6. Active Transport

   a. Transport of non-ionized compounds

   b. Active transport of sugars and amino acids.

   c. Pinocytosis and Phagocytosis.

B. Organic Chemistry

The essential chemical reactions that occur in the body are multitudinous and complex. A knowledge of organic chemistry is a prerequisite to a study of the chemical reactions occurring in a living organism. The following is a list of the topics covered in a brief introduction to organic chemistry, indicating those reactions which are of physiologic importance.

1. Hydrocarbons
   -alkanes, alkenes, alkynes, aromatic and alicyclic compounds.

2. Organic compounds containing elements in addition to hydrogen and carbon. Special emphasis on functional groups.

   a. Alcohols having a polar (hydroxyl -OH) and a non-polar character (alkyl group). Some chemical reactions of alcohols with physiological analogies:

      i Oxidation

      ii Esterification - many lipids contain carboxylic ester linkage. The acid may be organic or inorganic. The esters of H_3PO_4 (phosphorylated sugars and phospholipids) and H_2SO_4 are of great significance in biochemistry.

      iii Ether formation, (substituting sulfur for oxygen) thioethers and disulfides play an important role in protein structure.

   b. Aldehydes and Ketones

      Sugars and polyhydric alcohols and either aldehydes or ketones. Chemical reactions of aldehydes and ketones of physiologic interest include the following:

      i Oxidation

      ii Reduction

      iii Hemiacetal and acetal formation
      -the aldose sugar exists in solution primarily as hemiacetals
      -aldehydes may also form thiohemiacetals and and thioacetals with al[illegible]

$$R-\overset{H}{C}=O \;+\; R^{1}SH \longrightarrow R-\underset{S-R1}{\overset{H}{C}}-OH$$

      iv Aldol Condensation - formation of -hydroxyl-aldehydes or ketones. -hydroxy acids derived from these are of great importance in fatty acid metabolism.

   c. Carboxylic Acids

      Some physiologic important reactions of carboxylic acids are:

      i Reduction

      ii Ester and thioester formation

iii Acid anhydride formation (Anhydrides found in nature include those of H_3PO_4 - ATP and acetyl phosphate.

iv Amide formation - peptides

d. Amines - and their derivatives are involved in reactions of amino acids, lipids, and nucleic acids. Many drugs and pharmacologically active compounds are amines.

e. Amino acids and proteins

f. Lipids; fats, oils, and soap.

g. Carbohydrates (optical isomerism not discussed)

C. Blood

Blood and its chemistry is studied concurrently with the circulatory system - (Human Biology).

Topics considered include:

1. Functions of blood.
2. Haematocrit and blood volume.
3. Red blood cell, blood count, cyanosis.
4. Anemias; iron and formation of red cells; Vitamin B_{12} Haemoglobin.
5. Destruction of red blood cells, jaundice.
6. Blood osmotic pressure, and haemolysis.
7. Blood groups and rhesus factor.
8. Blood clotting and anticoagulants.
9. Plasma, and plasma proteins and their functions (osmotic pressure, transport protein reserve, viscosity, buffering effects, antibodies).
10. Preparation of protein-free blood on which analysis is carried out for all or part of the remaining constiuents.

D. The Carriage of Gases and Hydrogen Ion Concentration

This important topic is treated simultaneously with the respiratory system.

Topic introduced with a brief review of the gas laws followed by the following:

1. Hemoglobin

2. Carriage of oxygen by the blood
   -dissolved in plasma
   -combined with hemoglobin of red cell

   (Muscle oxygen requirements in exercise mention at this point)

3. Anoxia; four types recognized.

4. Carbon dioxide transport

   Carbon dioxide carried by the blood in three ways.

   i. In solution

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \underset{\text{of blood}}{\overset{\text{at pH}}{\rightleftharpoons}} H^+ + HCO_3^-$$

ii. Combined with protein; formation of carbamino compound with hemoglobin and plasma protein.

iii. As bicarbonate; formation of bicarbonate; Na-pump; chloride shift.

5. Determination of blood gas tensions with the use of oxygen electrodes and CO_2 electrodes.

6. Brief review of $[H^+]$, pH and buffer

   a. pH of blood

   b. Maintenance of body pH by
   -protein as buffers, - proteins as weak acids and weak bases
   -hemoglobin as buffers

   c. Maintenance of blood pH by respiration.

   The pH of the blood (plasma) depends upon the ratio of HCO_3^-/H_2CO_3 in the plasma. This ratio is about 20,000 to 1 giving a pH of 7.4. At this pH this HCO_3^-/H_2CO_3 system is not an efficient buffer in vitro. In vivo buffering action of the HCO_3^-/H_2CO_3 system is due to the respiratory center. This center is stimulated by a fall in pH, resulting in an increase in pulmonary ventilation.

   The alveolar pCO_2 falls and the CO_2 in solution is reduced.

   From: $$pH = 6.1 + \log \frac{[HCO_3^-]}{[CO_2 \text{ in solution}]}$$
   it is seen that the blood pH change is resisted.

   Conversely, the respiratory center is inhibited by a rise in pH, pulmonary ventilation is reduced, CO_2 in solution in the blood rises and the pH change is minimized.

   i. Acidaemia

   Acids may enter the circulation and produce a fall in the blood pH as a result of production in the following ways:

   - Exercise leading to the formation of lactic acid
   - High protein diet
     The protein S is oxidized to H_2SO_4
     The protein P is oxidized to H_3PO_4
   - Ingested acids
     Vinegar
     Acids in soft drinks
     Ammonium chloride - this is converted to urea (neutral) and HCl

- In untreated diabetes mellitus, keto acids resulting from the imperfect oxidation of fats (acetoacetic acid + -hydroxybutyric acid).

All these acids are neutralized by the plasma sodium bicarbonate as soon as they enter the blood. Thus,

$$HX + NaHCO_3 \longrightarrow NaX + H_2CO_3$$

The plasma bicarbonate is reduced and from the Henderson-Hasselbalch equation, a fall in blood pH. However, this fall is limited by the respiratory stimulation which reduces the alveolar CO_2 and thus the CO_2 in solution. A new equilibrium is set up with both the HCO_3^- and the CO_2 in solution. The pH has changed only slightly, say from 7.4 to 7.35.

Alkalaemia: - a rise in the blood pH caused by: ingestio of alkali, e.g. $NaHCO_3$
- intake of ium citrate and sodium tartra which are metabolized to CO_2 and $NaHCO_3$. Compensated for by decreased pulmonary ventilation.

As in the case of acidaemic, the final correction takes place in the kidneys. The excess s um bicarbonate is excreted in the urine, and the plasma bicarbonate and respiration return to normal.

d. Other buffer systems in the blood

i. Plasma contain Na_2HPO_4 and NaH_2PO_4 in the ratio of 4:1. These form a buffer system since they will remove both hydrogen ions and hydroxyl ions from solution. This buffering system is more important in urine than in blo

ii. Buffering by Ammonia
- the enzyme glutaminase present in the renal tubular cells, catalyzes the hydrolysis of the terminal amino group of glutamine to form ammonia. Ammonia is a base and can accept H^+.

E. Digestion

Digestion is considered along with the digestive system. The physiotherapist is not primarily concerned with the details of digestion. Thus emphasis is placed not on the chemistry of digestion, but on the physiological mechanism by which secretion of digestive juices occur.

1. Brief consideration of alimentary tract

2. General prinicples of digestion
   - enzymes
   - brief review of carbohydrates, proteins and lipids
3. Digestive secretions and their control; saliva, gastric juice, pancreatic juice, bile and bile saits succus entericus.

F. Metabolism

Introduced with the production of heat and energy by oxidation of C and H brought about by enzymes, aided by coenzymes. Excess energy stored in high energy molecules, ATP and creatine phosphate.

1. Hydrolysis and phsophorolysis
2. Carbohydrate metabolism
3. Fat metabolism
4. Protein metabolism
5. Deamination and other pathways for excretion of nitrogen

G. Nutritional Requirements

Having dealt with the metabolic pathways of the individual food constituents, we are now in a position to consider the body as a whole.

Each day the diet must supply the body with:

Adequate calories
Vitamins
Mineral salts
Water

1. Respiratory quotient of carbohydrates and fats
2. Basal metabolic rate
3. Starvation - tiss[illegible] utilization for energy production
4. Vitamins
5. Dietary requirem[illegible] [illegible] mineral salts - C[illegible] P, Mg, I Fe, Na and K.
6. Dietary requiremen[illegible] of water
7. Fluid compartments and ion concentration
8. Ionic balance

H. The Kidneys and Excretion

This topic is integrated with the Excretory System.

The regulation of the internal environment by the kidneys is a comrosite of four processes:
- Filtration of the blood plasma by the glomeruli
- Selective reabsorption, by the tubules of materials required in maintaining the internal environment
- Secretion by the tubules of certain substances from the blood into the tubul[illegible]r lumen for addition to urine.
- Exchange of hydrogen ions and production of ammonia for conservation of base.

1. Basic principles of urine formation.

   a. Glomerular filtration
   b. Tubular reabsorption of

      i. Water - controlled by ADH
      ii. Food substances - amino acid and glucose
      iii. Inorganic salts (NaCl), controlled by aldosterone
      iv. Waste products

2. Function of Tubule Cells

   a. Secretion; para-amino hippuric acid (PAH), diodine, are secreted by tubule cells and eliminated from the body.

   b. Regulation of pH of the body
      - tubule cells secrete H^+ or OH^- ions; provides elimination of nonvolatile acid, ketone bodies, H_2SO_4 produced by protein metabolism, and H_3PO_4 produced by the metabolism of phospholipids.

   c. $NaHCO_3$ reabsorption

   d. Abnormal constituents of urine; protein, glucose, ketone bodies, bile, galactose, and phenyl pyruvic acid.

I. The Chemistry and Functions of Hormones

Chemical Structure:
Some are polypeptides; e.g. pituitary, parathyroid and pancreas; introduced by injection.
The thyroid and adrenal medulla hormones are benzene derivatives; the remaining are steroids.
Steroids and their derivatives have the cyclopentanoperhydro-phenanthrene nucleus.
Students are shown the relation between name and modified steroid structure; e.g. if a H atom is replaced by an OH^- group, the suffix -ol is used as in cholesterol and cortisol. If two hydrogen atoms are replaced by an oxygen atom, the suffix one is employed as in aldosterone, testosterone, etc.

Because of the lack of time not many of the hormones are considered. Brief mention is made of:

1. Thyroxine - hormone of the thyroid gland. Produced in the body from tyrosine, thus:

   Inorganic iodide, which is concentrated in the cells of the thyroid is organically bound and oxidized to iodine by the cytochrome enzyme system forming mono- and diiodo - compounds of tyrosine. Oxidative coupling converts diiodotyrosine to thyroxine.

   a. Action of thyroxine:
      - effects metabolism
      - regulation of thyroxine secretion by thyrotrophic hormone

- hypothyroidism and accompanying disorders
- hyperthyroidism --- disorders
- thyroid and blood cholesterol level

2. Parathormone - hormone of the parathyroid gland. Protein in nature; M. Wt. 15000. This hormone is important in calcium metabolism. Hypo- and hyper parathyroidism and accompanying disorders.

SPECIAL TOPICS

1. Chemistry of Muscular Contraction

The courses in Human Biology persued by the physiotherapy students in the third and fourth semesters concentrate on the locomotor systems. The chemistry of muscle contraction is treated at this time.

When muscle is active, the glycogen stones are depleted, oxygen is used up and carbon dioxide is formed. Muscle glycogen breaks down to pyruvic acid with the release of energy which is stored by the formation of high energy ATP molecules, and pyruvic acid is further oxidized to CO_2 and water in the citric acid cycle with the formation of many more ATP molecules. If the oxygen supply is inadequate, an oxygen debt develops and lactic acid is formed. After the exercise the oxygen debt is repaid by increase pulmonary ventilation which raises the oxygen intake. About 1/5 of the lactic acid is oxidized to CO_2 and H_2O and the energy from this reaction is used to re[illegible] the rest of the lactic acid.

SECOND YEAR CHEMISTRY

Instruction in the Organic Laboratory: Past, Present and Future

Wilmer Fife
Indiana University/Purdue University
Indianapolis, Indiana

Presented to a Concurrent Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 7, 1974.

Most of us take laboratory instruction in chemistry for granted. After all, chemistry is an experimental science and the laboratory is "where the action is"! Has this always been true of chemical education? Have students of chemistry always learned their chemistry in the classrooms and laboratories of the university? A quick look at some historical accounts of the early years of modern chemistry reveals that chemistry was first practiced by gifted amateurs, wealthy men, or men who attracted th financial support of wealthy patrons.[1] And chemistry was taught primarily in the pharmacist's shop, not the university laboratory.

Laboratory instruction at the university quickly developed early in the 19th century with Justus von Liebig as the foremost innovator. Although Liebig did not establish the first academic laboratory in chemistry, his laboratory at the University of Giessen, founded in 1824, was among the early ones and it is regarded as by far the most successful and productive of these early laboratories. Liebig called the laboratories of the other chemists "kitchens" and considered his laboratory to be the first true instructional laboratory in chemistry. The most notable feature of his laboratory program was a heavy emphasis on precise chemical analysis. Most chemists at this time were more [illegible] ned with metallurgical and pharmaceutical processes of a [illegible]rative or qualitative type.

What were the special characteristics of Liebig's laboratory that may provide insight into its success and perhaps some guidance for us even today? Ihde[1] gives the following description of Liebig and the Giessen laboratory:

> "There developed in the laboratory an esprit de corps which was a factor in spreading its fame. Liebig lived in the building and the students spent their entire day there; Aubel, the caretaker, complained about not being able to get them to leave. Liebig, a highly energetic man, had numerous projects under way at the same time. He gave the younger students little actual instruction in the laboratory, relying instead on his older students to act as his assistants in guiding the beginners in their work. The older students worked on original problems, turning in a report each morning on their progress the day before. Liebig discussed these reports with the various students in planning their future work. Thus there was a great deal of activity of different kinds, and the students educated one another. The research work done in the Giessen laboratory covered a wide range of subjects."

The energy and enthusiasm of Liebig are depicted as essential ingredients of his success. Also, the committment of large blocks of time by Liebig and his students is highlighted. Finally, Liebig b[illegible] to his work a penchant for detail - precise chemical [illegible]s, carefully planned and executed experiments, speci[illegible] signed apparatus. These same factors

1. (a) A.J. Ihde, The Development of Modern Chemistry, Harper and Row, New York, 1964, pp. 259-270.
   (b) J.R. Partington, A History of Chemistry.

may be found at the heart of any successful experimental program in any field of science.

Now let us turn to the successful instructional laboratory programs in chemistry today. What are their attributes? In all instances - so far as I know - tney are led by an energetic, enthusiastic person. And in a sense each of these programs represents a joint venture on the part of students and instructor to learn something new and significant. Many successful programs are organized along traditional lines with a new experiment each laboratory period and each experiment chosen to teach a particular technique or facet of organic chemistry. Several chemical educators have found an approach that I have labeled "Problem-Oriented" more to their liking. I will return to this approach for a more careful description in a few minutes. Integrated laboratory programs have become increasingly attractive as the traditional barriers between sub-fields of chemistry have been eroded by new research areas such as bio-inorganic chemistry or new curricular patterns which categorize chemistry by structural, dynamic, mechanistic, etc., concerns. Yet, another approach to laboratory instruction is available to some chemistry students today. A few COOP educational programs in which students divide their time and learning between the university and a place of employment grant academic credit for laboratory training in an industrial laboratory. This type of educational program may become more prevalent in the next decade.

My personal experience in organic laboratory instruction has led to the development of a "problem-oriented" program of a novel nature.[2] We sought a mechanism that imparts meaning to all of the student's laboratory experience. The experimental work in the more traditional laboratory programs has always seemed artificial and sterile to me. In fact, the only portion of the organic laboratory program of my student days that made a lasting impression on me was the course in qualitative organic analysis. This same experience has been related to me by other academic and industrial chemists. For all of us the most striking feature of the qualitative analysis laboratory was that it immersed us in a real problem-solving experience where the importance of techniques and chemical knowledge are reinforced by a larger goal, the solution to an understandable problem.

A problem-oriented laboratory program should include a series of experiences that leads students from problems that are easily conceptualized, e.g., the identification of unknowns, through problems of a more subtle and searching nature, e.g, the planning and execution of a multi-step synthesis. In between these components, my program has always included experiments that focus on relationships between structure and properties, and definition of reaction pathways. The programs

[2] W.K. Fife, J. Chem. Ed. 45, 416(1968).

of other instructors may differ considerably from mine since I believe the most important considerations for an instructor in planning a problem-oriented program are:

(a) The instructor should develop a sequence of experiences that take the students from simple, obvious concerns to those that require considerable basic skill and knowledge, i.e., problems that are of immediate interest to the instructor himself.

(b) The instructor must be genuinely interested in and enthusiastic about each part of the program.

I am confident that if the above two considerations are met, the laboratory program will be no less successful than that of Liebig and other outstanding chemists. It will then be incumbent upon the student to take up the quest and bring his energy and talent to bear on problems of significance.

What of the future? Will laboratory instruction in organic chemistry undergo much change in the next decade? I foresee several significant changes dictated by at least three forces: (a) a trend toward more variety in styles of educational programming to provide closer matches of student career goals with curriculum content and instructional techniques; (b) a trend toward more variety in student approaches to completing educational programs at a university (c) the financial plight of higher education.

It seems to me that these forces will result in more gadgets - audio-visual devices, CAI, TV courses, etc. - for education of large numbers of students with less demand for classroom and laboratory space, and less contact with an instructor. At the same time, chemical educators can promote instructional patterns that bring chemistry majors into closer, more extensive relationships with faculty. This means that we could see a return to some aspects of 19th century style education in which there are vast differences between the educational programs <u>in chemistry</u> for chemists and those for non-chemists. However, our goal and I believe it is a reasonable one, would be to use limited resources most effectively and provide each student with instruction that is most appropriate to his aspirations and talents.

A second significant consequence of the forces cited above will be the increasing popularity of COOP education. As a greater percentage of students enroll in colleges and universities near their home, it will be desirable for them to combine gainful employment with their educational pursuits. The fact that increasing numbers of young people are delaying enrollment at the university reinforces this trend. Thus, chemical educators must begin to develop mechanisms for giving appropriate recognition to professional and intellectual development whether attained in the traditional academic environment or in a variety of non-traditional settings. I see the years ahead as exciting and challenging ones for chemical educators.

The Use of Instruments in the Beginning Organic Laboratory

Richard L. Titus
University of Nevada
Las Vegas, Nevada

Presented to a Concurrent Session of the Fortieth, Two-Year College Chemistry Conference, University of Saskatchewan, Regina, Saskatchewan, June 7, 1974.

Most modern organic chemistry texts for a one year course discuss modern instruments and their uses. Just as a student gains an increased appreciation of organic chemistry by actually doing work in the laboratory so the student gains a much better appreciation of instruments by actually using them.

The decision to use extensive instrumentation in the organic laboratory course, however, presents problems. These problems are associated not only with the instruments themselves, but also with the impact they have on the rest of the laboratory; e.g., how to present them, when, what kind of experiments, etc.

In my opinion, the temptation to turn the organic laboratory into an instrumental analysis course should be resisted. It should be emphasized to the students that these instruments are not ends in themselves, but exceedingly useful tools which can supply a great deal of information, often unique, regarding the solution of real chemical problems.

The course in which we make the most extensive use of these instruments is the Organic Chemistry course for chemistry majors. This is a five credit course with three hours of lecture and one six hour laboratory.

Timing is a problem. We use Morrison and Boyd (1) at the University of Nevada, Las Vegas. The chapter on spectrometry (Chapter 13) comes for us, at the end of the first semester. In order not to delay the use of the instruments we introduce gas chromatography and infrared spectrometry (two topics that the students pick up quickly) early in the first semester and delay the use of the NMR and mass spectrometer until the second semester.

Now I would like to go quickly through the laboratory experiments used at UNLV not because they are important in themselves, but because they illustrate how we use the instruments. You will notice that we try as much as possible to have students working with unknowns or on individual projects. Our philosophy concerning this kind of laboratory experience is pretty well stated in an article in the Journal of Chemical Education written by Robert Smith.[2]

The First Semester Laboratory

1. Isolation and purification of a natural product; determination of melting point.
2. Simple and fractional distillation of an unknown mixture; analysis of fractions using the gas chromatograph.

3. Column chromatography.

4. Free radical chlorination of ethyl benzene[3]; determination of the relative reactivities of and hydrogens using the gas chromatograph.

5. Synthesis of ethylene bromide[4] and its analysis by GC and IR with correlation of infrared bands using the CRC Handbook[5].

6. Use of the catalytic hydrogenation apparatus; analysis of the product using GC and IR.

7. Isolation of nicotine by steam distillation[6]; analysis of product using TLC.

8. Multistep synthesis of a solid aromatic compound; analysis using IR.

9. Determination of the tagged carbon in a C-14 sample of acetic acid .

<u>The Second Semester Laboratory</u>

1. Synthesis of an alcohol using the Grignard reaction; analysis of product by GC and IR.

2. Acetoacetic or malonic ester synthesis; analysis of product by GC and IR.

At this point the student has finished with the formal experiments in the laboratory and he has become proficient in the use of the gas chromatograph and infrared spectrometer. The entire remainder of the semester (ten to eleven weeks) is devoted to qualitative analysis.

I believe the analysis of unknowns is a superb teaching tool for many reasons and one of the most important is that it ties the lecture material together for the student. In addition, qualitative analysis is the ideal way to utilize modern instrumentation. The power, sensitivity, and limitation of these instruments are brought into sharper focus as they are used by the student.

For this portion of the course the student has at his disposal free use of the gas chromatograph, infrared, preparative scale gas chromatograph, UV, NMR, and one analysis using the mass spectrometer.

Each student has one single unknown to identify plus a three component mixture. To aid them the students use texts by Shriner, Fuson, and Curtin[8] and Cheronis and Entrikin[9]. In addition, the students have access to the Sadtler IR, UV, and NMR spectra plus several compilations of mass spectra.

Little emphasis is placed on the correct identification of the compound. The students are graded most heavily on their derivatives. The derivatives may be chemical or a properly interpreted and meaningful instrumental analysis. The students are allowed up to four instrumental derivatives; the rest must be chemical.

There are many advantages of the use of instruments in the laboratory. Some of these are:

1. Students like to be taught a subject as it really is.
2. Students are pleased and impressed when they learn how to use an instrument.
3. It is difficult to give an appreciation of sample preparation, instrumental operating parameters, etc. in the lecture.
4. Instruments are impressive selling points for prospective majors.
5. Students will encounter similar instruments in industry.
6. Prior use of these instruments is helpful in advanced courses in chemistry.

Of course, there are some negative aspects of the extensive use of instruments which should be considered.

1. High initial, maintenance, and repair costs.
2. Maintenance and repair time can be high for staff.
3. In course work a breakdown at a crucial time might mean the instrument would be repaired too late to be of service.
4. The instruments should never be placed in a wet-chemistry laboratory, so they may pose a space problem.
5. The time required for an analysis is appreciable. Therefore, if you have twenty to thirty students all needing to use the instrument at the same time you have generated a lot of waiting time. This can be partially overcome by:
    a. increasing the number of instruments
    b. have students work on different projects so they don't all need the instruments at the same time
    c. have instruments available outside of the scheduled class time

Favorable student response has convinced me that the advantages far outweigh the disadvantages in the use of instruments in the beginning organic laboratory.

References

1. Morrison, R. and R. Boyd. Organic Chemistry, 3rd ed. Allyn and Bacon, Inc., Boston, 1973.
2. Smith, R. J. Chem. Educ., 46, 273, (1969)
3. Roberts, R., J. Gilbert, L. Rodewald, and A. Wingrove. An Introduction to Modern Experimental Organic Chemistry, p. 101, 2nd. ed., Holt, Rinehart and Winston, Inc., New York, 1969.

4. Swinehart, J. Organic Chemistry, An Experimental Approach, p. 44, Appleton-Centruy-Crofts, New York, 1969.

5. Weast, R. Handbook of Chemistry and Physics, 48th ed., The Chemical Rubber Publishing Co., Cleveland, Ohio, 1967.

6. Hart, H. and R. Schuetz. Laboratory Manual for the Fourth Edition of Organic Chemistry, p. 287, Houghton Mifflin Co., Boston, 1972.

7. Wright, J. "An Undergraduate Organic Experiment with Carbon-14" J. Chem. Educ., 4? 206, (1963).

8. Shriner, R., R. Fuson, and D. Curtin. The Systematic Identification of Organic Compounds, John Wiley and Sons, Ind., New York, 1967

9. Cheronis, N. and J. [illegible] Semimicro Qualitative Organic Analysis, 2nd. ed. Interscience Publishers, Inc., New York, 1957.

CHEMISTRY FOR NON-SCIENCE MAJORS

Contemporary Chemistry in the Classroom

Edward A. Walters
University of New Mexico
Albuquerque, New Mexico

Eugene M. Wewerka
University of California
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

Presented to a Concurrent Session of the Thirty-Eighth Two-Year College Chemistry Conference, Pasadena City College, Pasadena, California, March 30, 1974.

In this paper we briefly describe the content and general philosophy of a one-semester course in chemistry for nonscience majors that we have taught for the past three years at the University of New Mexico in Albuquerque and its branch in Los Alamos. Our approach in teaching this course has been to emphasize the fundamental concepts of chemistry in such a manner that they are not obscured by the difficult language of chemistry or by mathematics. Some of the basic concepts that we deal with early in the course are the atomic structure of matter, thermodynamics, molecular dynamics, the foundations of quantum chemistry and bonding theory. Near the middle of the semester, we begin to apply the basic principles covered in the first part of the course to some of the technological problems of contemporary society. The precise problems have varied from semester to semester depending upon student interest, but have included radioactivity and nuclear processes, the energy crisis, household chemistry, drugs and pharmaceuticals, agricultural chemistry, chemistry of the internal combustion engine, refinery operations and petrochemicals, polymers, the chemistry of life, and environmental pollution. The role of energy in determining the course of change, both at the atomic and at the macroscopic levels, is particularly emphasized throughout the course. Regarding textbooks, we have found that none of the currently available texts appropriate for this course provides the necessary perspective for our a-proach. Consequently, we have written a textbook to fill this deficiency. Its title is Contemporary Chemistry: Concepts and Issues, and it will be published by Charles E. Merill Publishing Company in late February 1974.

Fundamental Chemistry: One Course For All Others

LeRay J. Anderson
Santa Ana College,
Santa Ana, California 92706

Presented to a Symposium on Chemistry and Careers at the Thirty-Eighth, Two-Year College Chemistry Conference, Pasadena City College, Pasadena, California, March 29, 1974.

I should clarify one thing at the outset - the subject of this paper is not at the name implies. I thought this should be mentioned, lest anyone think that we teach only one course in chemistry at Santa Ana College. I would like to acknowledge and express my appreciation to two members of our staff, Mrs. Theodora Edwards and Dr. Walter Brooks who have given me aid in developing the courses which I intend to discuss with you.

I suppose my background in pharmacy and medicinal chemistry has somewhat colored my philosophy regarding specialized courses. I remember as an undergraduate pharmacy student that two courses were offered at Idaho State College in Qualitative-Quantitative Analysis. One of the courses was for chemistry and science majors in general, while the other course was offered by the school of pharamcy and designed for pharmacy students. I noted that several pharmacy students changed their majors from pharmacy to other fields of science and then were required to retake the qualitative-quantitative course offered by the chemistry department. I feel such a situation is not necessary and is certainly not fair to the student. Such a dilemma for the student can be overcome by offering a course on a sufficiently broad basis to meet the needs of students in certain general, but related areas.

Let me quickly say that the "pendulum" can swing too far the other way and I am certainly not advocating that every one in any area of science should be required to take the majors course in general or organic chemistry. Quite to the contrary, and it is about this problem that I would like to speak for a few minutes. A course should do for the student what is needed for his chosen field of interest, with a little latitude for change of mind.

Before I discuss the present status of the year course in Fundamentals of Chemistry as we have developed it at Santa Ana College, let me give you a little background which may be of help in understanding the approach we have taken. When I came to Santa Ana College eleven years ago only one pre-Chemistry 1A or low level course was offered which was called Chemistry 2. After about two years it was felt that this course should really be separated into two courses;

Chemistry D, which was and is designed as a preparatory course for Chemistry 1A and

Chemistry 2A, designed for nursing, home economics and liberal arts majors in general.

It is the latter course that I will be discussing. The format and presentation of the 2A course stayed fairly constant until about 3-4 years ago, when the college was developing programs in the area of Home Economics, various levels of Nursing, Water Treatment and Environment. Two things became apparent very quickly, we had to meet the needs of the students in the various disciplines, although each being small in number, and related, yet diverse. It was also emphatically brought to our attention that the courses must have the transferability to the four year schools for those students desiring to go further in their chosen education program. This in itself is a mammoth requisite, considering that the transfer may be made to one of six or more neighboring colleges. In certain respects it was fortunate that I was chairman of the Science Division for the two years prior to this one, which gave me a better insight into the transfer problem. (If any of you would like to appreciate more the problems of transfer, try serving as a Division Chairman or Divison Counselor and sit down with perhaps 15 college catalogs and try to ascertain any uniformity among them.) I would like now to show how we have found success in offering a single course (either 1 or 2 semester) which meets the students needs and which will be accepted at a four year institution. As the transfer program for both nursing and home economics (Food and Consumer Studies) gained momentum, it became even more urgent that we serve the needs of the transfer student and that the chemistry course for these areas must articulate with most of the four year institutions in the area offering such a curriculum. To do otherwise would be grossly unfair to the student. The question arises as to how one achieves this.

We had received from CSULB their desire that we modify our Chemistry 2A to include more coverage of organic chemistry. After several meetings with representatives from their nursing, home economics and chemistry departments, we arrived at a common ground for course content for a one semester course which we then called Chemistry 7. This fulfilled their requirement for the first semester of their one year course and allowed our students to proceed on to the second semester of this course. We have elected, starting next year to offer a two semester sequence, the content of which is about 1/3 general, 1/3 organic, and 1/3[*] biochemistry.[1] Thus our current Chemistry 7 will become 7A[*] and will be followed by Chemistry 7B[*] to complete the year sequence and this will closely parallel the Chem 200, 300 at CSULB. CSULA offers also such a year course, but they have the advantage (in this case) of being on a quarter system, so each quarter would cover the above mentioned 3 areas consecutively. Much the same situation prevails at CSU Hayward and at the 2 campuses of the California State Polytechnic University, all of which are on the quarter system.

One observation about the Chemistry 7AB course should be noted relative to the other schools mentioned. Each semester is a 5 unit course for a total of 10 units for the year, as compared to 8 semester units for the other colleges cited. There are 2 reasons for this. We at SAC feel very strongly about teaching basic fundamental concepts, rather than just a lot of interesting but perhaps random topics. Our 7AB students transfer, not only to several different institutions, but also are following different curricula, thus it is felt that the 5 units is necessary for adequate presentation of fundamentals and topic coverage. I don't think that 1 or 2 semester units extra will unduly put a hardship on any student, but may in the long run prove to be very beneficial. Some majors require only 1 semester of fundamentals of chemistry, Chemistry 7A.

The secret of having a course meet the students needs, especially from a transfer standpoint, is meeting with representatives of both 2 and 4 year coll s in your area, to discuss their requisites, and also to h them see what we in the 2 year college can provide for their potential students. It takes a bit of "conference leg work" to make course articulation a reality. As an example, we have worked with 3 neighboring 4 year institutions, with the result that over 90% of our transfer students completing our 7AB are adequately prepared in chemistry so as to proceed on into specialized courses. It hasn't all been easy but we feel we have been very successful as we talk to the students who have continued their education beyond the community college.

It is felt by some educators that the 4 year school dictates to the 2 year school as to the type and level of courses they should present. However, it has been our experience with the 4 year schools that it is just as important to them to receive adequately prepared students from the community colleges. This then mandates that we at the community colleges actually work in a give and take spirit with our big brothers to develop appropriate curricula on the part of each, which will really benefit not just us, but particularly the students involved. In fact I feel that if the science departments at the commun-

ity colleges are to survive, it is absolutely necessary that we have this articulation.

Relative to a chemistry course for the paramedical sciences, which our Chemistry 7AB is, I forsee larger enrollments. In fact, I believe that the enrollments at the community colleges in this 1 year course, will soon be larger than the enrollments in the standard 1AB course designed for science majors. To give you one example, we recently submitted to the dental school at USC the course outlines and course coverage for Chemistry 7AB for their evaluation. The Director of Admissions was very pleased with this course and indicated that it would fulfill the entire chemistry requirement for their majors in the 4 year dental hygiene curriculum. Yes, it does take effort and cooperation for these things to happen, but it is worth it when we note the success of our transferring students.

In summary let me cover these points.

(a) A year course for the paramedical sciences is needed.

(b) In most cases it is felt that a single course (two semesters), if properly taught can cover the needs of most of the students majoring in these fields.

(c) The year course should consist generally of about 1/3 general chemistry, 1/3 organic chemistry, and 1/3 biochemistry. Fundamental concepts, particularly in the general chemistry section should be thoroughly covered and taught to the student.

(d) Discussion and articulation with neighboring 4 year schools are a must, in order to properly tailor the course to the needs of the transfer student.

(e) It is felt that enrollments in such a course are going to increase at the community colleges if the colleges will accept the challenge to develop appropriate course content.

Thank you.

---

[1] Biochemistry in the Introductory College Chemistry Course, J.M. Sturtevant, J.Chem. Ed. 44, 184 (April 1967).

COMMITTEE ON CHEMISTRY IN THE TWO-YEAR COLLEGE

Division of Chemical Education

American Chemical Society

1975-76 ROSTER OF COMMITTEE MEMBERS

Chairman — Cecil Hammonds, Penn Valley Community College, Kansas City, Missouri 64111 (816-756-2800) [illegible]
Past Chairman — William T. Mooney, Jr., El Camino College, via Torrance, California 90506 (213-532-3670)
Chairman Elect — Douglas J. Bauer, Mohawk Valley Community College, Utica, New York 13501 (315-792-5352 or 315-792-5378) [illegible]
Treasurer — Ethelreda Laughlin, Cuyahoga Community College, Western Campus, Parma, Ohio 44130 (216-845-[illegible])
Secretary — Robert Burham, Grand View College, Des Moines, Iowa 50316 (515-266-0867)
Secretary — Katherine E. Weissmann, Charles Stewart Mott Community College, 1401 East Court St., Flint, Michigan 48503 (313-235-7541) (517-845-3670)
Editor — Jay Bardole, Vincennes University Junior College, Vincennes, Indiana 47591 (812-882-3350)
College Sponsorship Chairman — Dr. J. Smith Decker, 444 East First Street, Mesa Arizona [illegible]

Region I — Western States

(Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming)

Western Regional Vice-Chairman (1975-1976): Mabel K. Armstrong (1978): Lane Community College, Eugene, Oregon 97405 (503-747-4501)
BIEVER, Keith J. (1978): Bellevue Community College, Bellevue WA 98004 (206-641-0111)
BOND, Douglas (1976): Riverside City College, Riverside, CA 92506 (714-684-[illegible])
HUBBS, Robert (1976): De Anza College, Cupertino, CA 95014 (408-257-5550)
LUNDSTROM, Richard A. (1977): American River College, Sacramento, CA 95841 (916-484-8137)
SCOTT, Peter (1977): Linn-Benton Community College, Albany, OR 97321 (503-928-2361)
STERNER, Wanda (1977): Cerritos College, Norwalk, CA 90650 (213-860-2451)
TAYLOR, Robert (1978): Community College of Denver, North Campus, Denver, CO 80216 (303-287-[illegible])
TRUJILLO, Anthony (1977): San Joaquin Delta College, Stockton, CA 95204 (209-466-2631)
VANDERBILT, A. H. (1978): Sierra College, Rocklin, CA 95677 (916-624-3333)
WILLIAMS, Gordon H. (1978): Monterey Peninsula College, Monterey, CA 93940 (408-375-9821)
WESTOVER, Ross (1977): Canada College, Redwood City, CA 94061 (415-364-1212)
WYATT, William H. (1978): El Paso Community College, Colorado Springs, CO 80903 (303-471-7546)

Region II — Southern States

(Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas)

Southern Regional Vice-Chairman (1975-1976): Anne P. Minter (1977): Roane State Community College, Harriman, TN 37748 (615-354-3000) (615-[illegible]-7124)
ALLISON, Harrison (1977): Marion Institute, Marion, AL 36756 (205-683-2871) (Mail to P.O. Box 548, Marion, AL 36756)
BARTLEY, Edith (1977): Tarrant County Junior College, South Campus, Fort Worth, TX 76119 (817-534-[illegible])
CHEEK, William R. (1976): Central Piedmont Community College, P.O. Box 4009, Charlotte, NC 28204 (704-372-[illegible])
FREEMAN, Charles (1976): Mountain View Community College, Dallas, TX 75211 (214-747-2200)
GRIFFIN, William W. (1977): Hinds Junior College, Raymond, MS 39154 (601-857-5261)
HOWARD, Charles (1977): University of Texas, 4242 Piedras Drive E S-250, San Antonio, TX 78284 (512-734-[illegible])
HUSA, William J. (1978): Middle Georgia College, Cochran, GA 31014 (912-934-6221)
INSCHO, F. Paul (1976): Hiwassee College, Madisonville, TN 37354 (615-442-2128)
KUCHERA, John (1976): Northern Oklahoma College, Tonkawa, OK 74653 (405-628-2581)
MILTON, Nina (1978): St. Petersburg Junior College, St. Petersburg Campus, St. Petersburg, FL 33733 (813-544-2551)
MITCHELL, John (1976): Tarrant County Junior College, Hurst, TX 76053 (817-281-7860)
SIMS, Joyner (1976): Chipola Junior College, Marianna, FL 32446 (904-482-4935)
SINK, W. G. (1978): Davidson County Community College, Lexington, NC 27292 (704-249-8186)

Region III — Midwestern States

(Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin)

Midwest Regional Vice-Chairman (1975-1976): Virginia Malik (1978): Cuyahoga Community College, Western Campus, Parma, OH 44130 (216-845-4000)
AUWATER, Wendell (1976): Sinclair Community College, Dayton, OH 45402 (513-226-2550)
BALLINGER, Jack (1977): Florissant Valley Community College, Florissant, MO 63135 (314-524-3020)
BLOUGH, Alvin (1976): Hesston College, Hesston, KS 67062 (316-327-4221)
BURNS, Ralph G. (1977): East Central Community College, Union, MO 63084 (314-583-5193)
CLOUSER, Joseph L. (1978): Wm. Rainey Harper College, Palatine, IL 60067 (312-398-4300)
DHONAU, Curtis A. (1977): Vincennes University Junior College, Vincennes, IN 47591 (812-882-3350)
ELKINS, I. Dean (1977): Henderson Community College, University of Kentucky, Henderson, KY 42420 (502-827-2867)
HITTEL, David (1977): Bay de Noc Community College, Escanaba, MI 49829 (906-786-5802)
JOHNSON, Cullen (1978): Cuyahoga Community College, Metropolitan Campus, Cleveland, OH 44115 (216-241-5966)
KOCH, Frank (1976): Bismarck Junior College, Bismarck, ND 58501 (701-223-4500)
REDMORE, Fred (1978): Highland Community College, Freeport, IL 61032 (815-235-6121 — Ext. 331)
ROSKOS, Phillip (1976): Lakeland Community College, Mentor, OH 44060 (216-951-1000)
SCHULTZ, Dorothy (1976): Jackson Community College, Jackson, MI 49201 (517-787-0800)
SOSINSKY, Jack (1977): Loop Junior College, Chicago, IL 60601 (312-269-8056)
SUSKIND, Tamar (1976): Oakland Community College, Auburn Hts., MI 48057 (313-852-1000)
WINKELMAN, John (1978): Illinois Valley Community College, LaSalle, IL 61354 (815-224-6011)

Region IV — Eastern States

(Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, Vermont, West Virginia)

Eastern Regional Vice-Chairman (1975-1976): Herman Stein (1977): Bronx Community College, City University of New York, Bronx, NY 10453 (212-367-7300)
ADAMS, David L. (1977): North Shore Community College, Beverly, MA 01915 (617-927-4850)
AYER, Howard A. (1977): Franklin Institute of Boston, Boston, MA 02116 (617-423-4630)
BERKE, Thomas (1978): Brookdale Community College, Lincroft, NJ 07738 (201-842-1900)
Mother Bohdonna (1977): Manor Junior College, Jenkintown, PA 19046 (215-884-2361)
BREEDLOVE, C. H. (1976): Rockville Campus, Montgomery College, Rockville, MD 20850 (301-762-7400)
BROWN, James L. (1976): Corning Community College, Corning, NY 14830 (607-962-9242)
CUCCI, Myron W. (1978): Monroe Community College, Rochester, NY 14623 (716-442-9950)
FINE, Leonard W. (1977): Housatonic Community College, Bridgeport, CT 06608 (203-366-8201)
HAJIAN, Harry G. (1978): Rhode Island Junior College, 199 Promenade Street, Providence, RI 02908 (401-331-5500)
JEANES, Opey D. (1976): John Tyler Community College, Chester, VA 23831 (703-748-6481)
SANTIAGO, Paul J. (1978): Harford Community College, Bel Air, MD 21014 (301-838-1000 — Ext. 262)
SCHEIRER, Carl Jr. (1978): York College of Pennsylvania, York, PA 17405 (717-845-[illegible])
SOLLIMO, Vincent (1976): Burlington County College, Pemberton, NJ 08068 (609-894-9311) (Mail to Box 3788, Browns Mills, NJ 08015)
VLASSIS, C. G. (1976): Keystone Junior College, La Plume, PA 18440 (717-945-5141)
WILLIAMS, Thelma (1978): New York City Community College, 300 Jay Street, Brooklyn, NY 11201 (212-643-[illegible])

Region V — Canada

Canadian Regional Vice-Chairman (1975-1976): Graeme Welch (1978): John Abbott College, Box 2000, Ste. Anne de Bellevue, Quebec [illegible]
DEAN, David (1977): Mohawk College of Applied Arts and Technology, 135 Fennell Ave. W., Hamilton, Ontario
DIEMER, Jane (1976): Camosun College, 1950 Lansdowne, Victoria, B.C. [illegible]
JARDINE, Doug (1978): Capilano College, 2055 Purcell Way, North Vancouver, B.C. [illegible]
KIMMEL, Terry (1976): Southern Alberta Institute of Technology, Calgary, Alberta
LeCOUTEUR, Penelope (1978): Capilano College, West Vancouver, B.C.
LYONS, James (1978): John Abbott College, Box 2000, Ste. Anne de Bellevue, Quebec [illegible]
MARSTON, Robert (1977): Grand Prairie Regional College, Grande Prairie, Alberta
ORPWOOD, Graham (1976): St. Lawrence College of Applied Science and Technology, P.O. Box 6000, Kingston, Ontario
PILON, Jean Guy (1977): C.E.G.E.P. de Jonquiere, [illegible], Jonquiere, Quebec
[illegible] (1976): College Ahuntsic, [illegible] Rue Saint-Hubert, Montreal [illegible], Quebec [illegible]
WILLIAMS, Charles (1977): P.O. Box 576, Halifax, Nova Scotia

Revised Copy [illegible]

[illegible]