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ABSTRACT

This document includes contributed short papers and summaries of recorded remarks from four meetings of the 1968-1969 Two-Year College Chemistry Conferences. Topics include the two-year college chemistry teacher, chemistry laboratories, teaching first-year college chemistry, a sophomore level chemistry course for both majors and nonmajors, organic chemistry in the two-year college, and innovations in teaching chemistry. Also discussed is chemistry for the medical, dental, pharmacy, and allied health student. Appendices contain information about chemistry in two-year colleges in the U.S. and Canada, transfer chemistry programs, short courses on chemical theory, chemical education seminars and courses, and teaching aids centers. (MH)

Two-Year College Chemistry Conference

PROCEEDINGS

Sponsored by
Division of Chemical Education
American Chemical Society

1968-1969 Academic Year

11-12 October, 1968
Second Eastern Regional Conference
Franklin Institute of Boston
Boston, Massachusetts

11-12 April, 1969
Ninth Annual Conference
Metropolitan State Junior College
Minneapolis, Minnesota

13-14 June, 1969
Third Western Regional Conference
University of Utah
Salt Lake City, Utah

Chairman: William T. Mooney, Jr , El Camino College, Torrance, California
Secretary: Robert Burham, Grand View College, Des Moines, Iowa
Editor: Kenneth Chapman, American Chemical Society, Washington, D. C.

THE CHAIRMAN ACKNOWLEDGES

The Two-Year College Chemistry Conference ($2YC_3$) completed its ninth year in the summer of 1969 in Salt Lake City and 1968-69 was the first year of the expanded program of four meetings. The $2YC_3$ programs are made possible throughtthe support of the Division of Chemical Education and. in particular, its Executive Committee. Successful conferences require the cooperation of American Chemical Society Regional Meeting personnel, Soceity National Office personnel, and host institution administration and faculty. High quality and smooth running programs require the time and devotion of the members of the $2YC_3$ Committee of the Division. Successful programs also require accomplished persons willing to graciously make presentations and interested attendees willing to participate.

For the Boston meeting key work was done by Mr. Howard Ayer, Franklin Institute of Boston, who served as program and local arrangements chairman and by Dr. Robert Eddy, Tufts University, our liaison with the Northeast Regional ACS Meeting. The Franklin Institute was an outstanding host institition.

Although the Tallahassee meeting was an abbreviated Saturday afternoon session those who attended the Florida State University sessions felt that Ann Stearns, Columbus College, and Harrison Allison, Marion Institute, had developed an interesting and informative program. DeLos DeTar of Florida State University was our Southeast ACS Regional Meeting liaison.

The Minneapolis meeting was probably the finest of the eighteen held during the first nine years. The leadership of Curt Dhonau, Vincennes University Junior College, in developing the program; the diligent work of the staff of the Metropolitan State Junior College in providing necessary facilities and services; and the care for local arrangements provided by Miss Louise Heine of Metropolitan all deserve special mention.

Without the organization and hard work of Dr. J. Smith Decker, Phoenix College, the Salt Lake City meeting at the University of Utah would not have turned out as well as it did. Malcolm Renfrew, University of Idaho, and A. C. Francis, Kennecott Copper, served as our liaisons with the ACS Northwest Regional Meeting.

As $2YC_3$ Chairman I was aided immensely by the wise counsel and hard work of Mr. Robert Burham, Grand View College, Conference Secretary, and Mr. Kenneth Chapman, American Chemical Society, Conference Proceedings Editor, who worked with me on the Steering Committee to provide the necessary continuity and guidance. Without the many hours of secretarial work put in by the $2YC_3$ office secretary, Mrs. Margery Mooney, there could not be a $2YC_3$ program of the scope that we have. She is not a chemist nor does she attend the conferences byt she keeps the information flowing.

On behalf of the conference attendees and the members of the $2YC_3$ Committee, I wish to express our appreciation to the many persons accepting formal responsibilities for the various meetings. I also wish to thank each attendee for his contributions and the colleges, universities and other organizations that made their presence possible.

William T. Mooney, Jr.
1968-1969 Chairman
Two-Year College Chemistry
Conference Committee
Division of Chemical Education
American Chemical Society

A Note from the Editor

The success of the $2YC_3$ has produced increasingly complex programs to meet expressed needs of two-year college chemistry faculty. The Proceedings Editor's tasks of presenting the ideas and approaches to chemistry instruction of many different persons is complicated by the volume of material. The generous assistance of many, many individuals in gathering material is deeply appreciated. Without their assistance, these Proceedings would never have developed.

The increasing trend to utilize recorders instead of asking for written papers for all presentations has produced a somewhat freer atmosphere in $2YC_3$ programs. However, this approach results in the risk of misinterpretation during the transcription and editing process. The Editor asks the forgiveness of those whose ideas are improperly presented in these Proceedings.

Kenneth Chapman
Editor
1968-1969 Proceedings

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THE TWO-YEAR COLLEGE CHEMISTRY TEACHER

Donald Allen
Eisenhower College

(A summary of recorded remarks.)

The Ph.D. degree has become the hallmark of achievement in the world of academe. It is no secret, though, that this degree makes no pretense of helping to prepare the graduate student to become a more skillful teacher. The objective of Ph.D. training is that of independent investigation and in this role has enjoyed great success. Of course, research lies at the very heart of any science and all agree that experience and discovery should continue to be an important part in the training of every college teacher. However, a study made by the University of Chicago several years ago established that the majority of college professors publish only one research paper, that of the Ph. D. thesis. The major bone of contention with relation to doctoral programs for the prospective college teacher is the emphasis that the degree places on research alone. Since the start of the twentieth century thoughtful voices have urged for reform. From France, William James in 1903 expressed great concern "less the Ph.D. octopus tarnish the true spirit of learning in the graduate school". In recent years the demands for reform have been championed by such imminent contemporaries as Earl McGraff, Everett Walters, Steven Spur and Vincent Powers, to name only a few. Perhaps the time is come when we should pause to look at the contemporary scene and to see that some of these proposals have relevance in 1969.

Considerable evidence supports the contention that the long postponed reform movement in graduate education is already underway. Two major emphases are evident in the recent literature relating to new types of graduate programs. The first accepts the present Ph.D. system as adequate for the needs of the college teacher but seeks to alleviate the vexing dissertation problem by interposing between the Master's and the Doctorate an intermediate degree. The second regards the intermediate degree as but a palliative which leaves essentially untouched the Ph.D.'s lack of concern to the teaching function.

In the Fall of 1968 Yale initiated a plan to award the Master of Philosophy degree to all students who had completed all Ph.D. requirements except the dissertation. Rutgers, in New Jersey followed a similar course. Michigan, for years, has awarded a Candidate's Certificate to all students who are admitted to candidacy to the Ph.D. degree. Minnesota, Indiana and Northwestern, I understand, also award such certificates. The University of California at Berkeley now grants a Candidate in Philosophy degree when all requirements for the Ph.D. except the dissertation have been fulfulled. In many European countries the Candidate's Degree is well established. In Finland, Norway, Sweden and Denmark, it represents a level of achievement en route to the doctorate. he later is based solely on satisfactory completion of a research investigation. However, a few universities have been willing to accept the "Candidate's" concept thus far.

Proponents of the intermediate degree point out that the students have attained a level of achievement substantially beyond the master's degree, the varieties of which now exceed three hundred in number. Some authorities feel that this degree may help slow any erosion in Ph.D. quality. It may well be that the intermediate degree is an equitable way to handle a long standing problem. While some see it as assisting in the identification of a pool of teachers with qualification substantially beyond the masters, others feel it will add only to the confusion of an already complicated degree picture.

The second school of thought contends that the intermediate degree, while serving to identify a higher level of achievement along the way to the Ph D., really accomplishes nothing in making training more relevant to college teaching There should be specific aspects of the program directed to this. The Tennessee Master of Arts in College Teaching is designed to upgrade relevance to the college teaching function. It extends by about one third the usual number of Master's Degree credits and in chemistry this is somewhat in excess of that required for the Ph.D. degree Candidates for this degree serve as assistants for six quarters or alternatively as teaching interns in nearby two-year colleges. All students participate in a seminar in college teaching and write a thesis, which in science could be a summary of a research investigation. About 50 students each year enroll in this Program with about 20-25 degrees awarded annually.

Many staff members question whether the master's degree will ever be highly esteemed as a college teaching credential, but spokesmen for the Tennessee Program feel that the former prestige of the master's degree can be re-established by raising the level of this program.

The University of the Pacific has had in operation since 1961 a very impressive Ph.D. program for the teachers of college chemistry. It requires depth of study in a major area, two courses in each of three minor areas of chemistry, a comprehensive exam, a research project, a seminar in pure chemistry, a seminar on the problems of teaching college chemistry and a teaching internship under the supervision of a senior professor. In effect, this program superimposes upon a conventional Ph.D. program additional requirements relating to teaching. Iowa's program might serve as a prototype of a high level curriculum for prospective college chemistry teachers but it is obvious that any plan requiring four years for completion is unlikely to produce as many teachers as a two-year program.

Syracuse University has a somewhat similar Ph.D. program in science education. This includes advanced study in a field of chemistry, a bonafide research project and a program directly related to the objective of college teaching. At Carnegie-Mellon University in Pittsburgh a Doctor of Arts degree is offered in four areas--history, fine arts, mathematics and English. The plan provides a broad base but no less rigorous than that for the Ph.D. It is directed to train the teachers of two- and four-year colleges. This program includes two years of course work in a major field, an internship during which the student is a member of a curriculum group, two professional courses, materials and methods of insturction and cognitive processes, and for the thesis the student is to develop classroom materials in the subject matter of his major interest.

There are a number of Ed.D. programs which are subject centered that provide for training in the teacher function. We have recently heard of one at Temple University At Pennsylvania State University this is a university degree with the chairman of the subject matter department choosing the doctoral committee. Forty-five of the sixty credits are taken in the subject matter field, fifteen are taken in education. The dissertation must have relevance to the teaching of the major field.

Each of these programs has features which might very well be incorporated into a high level doctoral program for college chemistry teachers. Here is a proposal which in my opinion accomplishes these objectives. All graduate students would proceed together in the same program as far as admission to candidacy. At this time the candidates in philosophy degree would be awarded. The student would then make the decision whether to go the usual route of research or the Doctor of Art route. The former would clearly indicate a major interest in research, discovery of new knowledge, and would be trained to teach upper level university and graduate courses. The latter group would be designed for communicators of chemical knowledge, teachers, and would include some of the following: a research experience, a study of the history and philosophy of science, a teaching internship, interdisciplinary courses and the study of modern instructional media, i.e. films, video tapes, and computer assisted instruction.

Of course teaching and research are interrelated and should complement each other, but it is about time that we recognize that one person cannot WELL serve both masters. One must decide whether his principle preoccupation will be the discovery of new knowledge, research, or the communication of that knowledge, teaching. Clearly the mission of the two-year college and the four-year college is the latter. For those who expect to make the choice of teaching there should be a high level respected doctoral program. In the college teaching field anything less will be unacceptable as the highest credential.

A recent article in the Journal of Chemical Education, entitled "Trends in Doctoral Education" stated that the greatest need in graduate education is for a larger pool of baccalaureate chemists. The two and four-year colleges have the opportunity to replenish the pool of undergraduate baccalaureates which are so badly needed. Also these schools have recognized the need for skilled communicators of knowledge who will assist with the defining of the abundant harvest of knowledge which is so abundantly turned out in research. New knowledge today inevitably arises from the work of specialized research. The role of the smaller colleges located around this central university is to refine and transmit this knowledge.

The two-year colleges will employ an estimated one hundred thousand new teachers over the next decade. Through employment policies the two-year colleges will have a profound influence on the development of new types of graduate programs for the training of college chemistry teachers.

A TEACHER'S DEVELOPMENT IN A TWO-YEAR COLLEGE CHEMISTRY DEPARTMENT SOME KEY STUDIES

Robert Brasted
University of Minnesota

(A summary of recorded remarks.)

During its existence, the Advisory Council on College Chemistry became interested in the two-year college teacher. It gathered together dedicated, competent consultants in the field of teacher preparation and development to explore the preparation of two-year college chemistry teachers. Papers and critiques covered such areas as administrative attitudes, continuing education, vocational programs, new graduate degrees, special institute programs and the roles of the various types of educational institutions. An extensive, open-ended questionnaire was developed to enable the two-year teachers and administrators to be the voice for their institutions.

One administrator with the ability to make objective, accurate insights presented these comments at a meeting held in Dallas in January, 1968.

1. New degrees to meet the needs of the two-year college teachers can be advantageous. A person who intends to spend his life in education should not object to a few hours of course work in the psychology of education, especially when the unique two-year college audience is considered.
2. All agencies should work for allowing the teachers to catch up and keep up. Useful are sabbaticals, ACS Short Courses, short course institutes, university courses and occasional grants permitting teachers to serve internships.

3. Substandard degree programs should be deplored. Internships and teaching seminars should be an important part of the degree program.
4. Both the staff and the student should be sufficiently interested in the subject matter so that more than a single year of chemistry can be maintained. The proper teachers and subject matter must be provided in the two-year college to produce a useful citizen.
5. The atmosphere of the undergraduate and graduate education of chemistry students is not realistic for the future needs of the two-year chemistry teacher Once the prospective teachereis identified, he should be kept interested and enthused about the prospect of a career with young people.
6. The salary discrepancy between the staff members of the two-year college and four-year college teachers will be a factor in the quality of the teacher as it is between the high school teacher and the teacher in the two-year college.

In looking at the questionnaire it became quite evident that the problems facing junior colleges are not uniform throughout the country and often the problems that have arisen have not been expected. For instance, the University of Minnesota has always felt that if it could ring the Twin Cities with junior colleges, these colleges would eventually carry the main teaching load of our first year chemistry program. Instead, we find that we are attracting in increasing numbers a different type of student. While this is desirable, it demands a different type of program. Two-year college students come with different motivations, preparations and abilities from the usual four-year college students. Many two-year college students plan to transfer to the University, but do not. The transfer attrition rate is as high as sixty to eighty per cent. New methods of teaching ought to be designed not to automatically pass these students but to motivate them to enter areas where they can fulfill their objectives On the other hand, those who do transfer are entitled to the kind of education that they really need.

The two-year college teachers gave a strong endorsement to the National Science oundation Programs. The institutes where a master teacher and his presentation are observed along with recent developments in chemistry can be discussed are of value to the college teacher. Also more courses in educational pyschology, without being overburdened with education courses, are desired.

A perennial question faced in every program of instruction is, "What do you teach?" The solution is not clear but we must keep hammering at what are the most important items of the introductory course? Teaching aids are of great use to the instructor and funding must continually be found that will look for new ways in which these kinds of materials can be made available and help the teacher who is asking for assistance.

Many of the questions addressed themselves to the interface between the two-year and four-year colleges. The teacher in the two-year college does not know from year-to-year what the change in the curriculum will be in a four-year college. How can we expect the two-year college to produce a transfer student to fit into a program when that program is unique in the United States?

Not entirely divorced from the above is the teachers' request to become involved in a centrally located university. This could make library facilities and instrumentation available as well as continuing education and week-end courses. Centrally located industry can make heavy hardware available for training programs.

Another idea in vocational education, as done at Oklahoma State University is the B. S. offered in technical education. Too many of the technical instructors in two-year colleges are men who really know their trade, they know what must be done, but all of a sudden they are faced by a brand new college. They must devise a curriculum, outfit a laboratory, gather all the necessary physical equipment and design curricula. They are usually not qualified to do these things. In this degree program, technical educators are taught to choose instructional materials and design a course of study.

Any new degree program should not be down graded. The teachers themselves emphasized that their research experience had been valuable. The research person and the teacher can be trained the same - to a point - but the idea of the seminar, the teaching experience and internship are important to the one who is training mainly as a transmitter or an explainer of knowledge.

I think that we are in a position new to say that the time for the movement of the teacher from the high school to the junior college without additional training should stop. If it must occur, we have the obligation to provide for that teacher the necessary educational background and upgrading to make him comparable to the teacher found in the university or college.

TEN PROPOSED PROGRAMS FOR TWO-YEAR COLLEGE CHEMISTRY TEACHERS

William T. Mooney, Jr.
El Camino College

(Ed. Note: In 1967, a comprehensive questionnaire was distributed to two-year college chemistry teachers throughout the United States. The several hundred responses produced an abundance of data which proved difficult and time consuming to analyze. Mr. Mooney's analysis of the responses resulted in the proposed programs outlined below. These proposals were abstracted from a recording and may not faithfully portray Mr. Mooney's opinions on each program.)

1. A Ph.D. - extended. Programs are needed in chemistry with a college teaching objective or possibly even a title in chemical education. The course work and the needed research could be completed in summers with the possibility of a required one year of residence. This type of program is needed because many two-year college faculty members are not able to take extended periods of time away from their teaching situations. Both personal and employment-based reasons indicate that standard Ph.D. programs are too inconvenient to be a viable option to this group of people.
2. A chemical education seminar. This would need to be a series of chemical education seminars for two-year college faculty. They should be designed to enable teachers to develop more effective ways to present given topics, to develop and give tests, to present demonstrations and experiments, to select appropriate texts and materials, to create courses and to better read the needs of the students. They would also communicate new developments in chemistry teaching to the teachers.
3. A short course seminar. There is a general need to establish a center for short courses for which college chemistry teaching could be the central theme. This could include courses such as the ACS Short Courses, summer institutes and anything that could be presented in short periods of time might be very appropriate. Two-year college chemistry faculty must be kept abreast of what is new. They must have an understanding of the nomenclature, the concepts, the models and the experiments appropriate to specific areas of chemistry they are asked to teach. Faculty members are very interested in short seminars and workshops and very specific new topics such as coordination chemistry, infrared, NMR, molecular orbitals or intensive reviews of both modern develop-

ments and traditional topics. They are interested in short, critical survey courses in areas like those mentioned above, which would give them the collective, latest thinking in the field rather than one man's ideas. A course could be designed to allow them to critically evaluate new texts and materials. They want some short intensive alternatives to the traditional advanced graduate courses. They want to strengthen their subject matter background specially with respect to recent developments.

4. Imitative institutes. The purpose of imitative institutes for the teaching of chemistry in the two-year colleges is to enable these teachers to see and learn how masterful teachers present a topic and afterwards discuss the presentation and why it was done in the specific way. Such institutes could provide an opportunity to show different techniques to teach difficult topics and modern topics. They would also provide the opportunity to observe, analyze, compare and contrast different presentations of the same topic.
5. An instrumentation center. This is a proposal for the establishment of an instrumentation center designed specifically for college chemistry teaching. The reason for this is that many instructors ought to build and maintain their knowledge and ability for working with instruments. Instructors would like to collect in a central location all currently available instruments suitable for use in the two-year college program. Then they would be able to go to that location and work with the instruments to develop expertise in using instruments as teaching tools. Instructors want courses that will develop, specific instrumental techniques and train them in instrumental methods. They want someone to develop a system that will produce new instrumental experiments and supplement those that they currently use.
6. A teaching aids center. The teachers feel there is a need to build a collection of all the currently available teaching aids. Again, this needs to be a center where they can use, evaluate and discuss the various aids. This center would include visual materials, models, audio-visual materials, charts, devices, etc. The faculty members want opportunities to inspect, review and evaluate these items and examine such a collection in terms of their own teaching situation. They want the opportunity to prepare and construct some of these aids for use in their own institutions but they have neither the shop materials nor many of the resources at their own institutions to do this. They want someone to disseminate information on tested teaching aids in chemistry and make recommendations on them for use in their teaching situation. They want someone to train them in the effective use of these teaching aids. They want someone to help identify the needs for new aids and encourage the development of inexpensive aids.
7. A chemical research center for college chemistry teaching. This could provide the two-year college faculty member with an opportunity to establish and engage in a small but significant and stimulating research program under the guidance and general direction of a competent research chemist. This could also provide a program in which the two-year college faculty member would direct two-year college students and give them an opportunity to engage in the trials and tribulations of research as a part of a research team. The faculty member would be provided with an opportunity to actively participate in activities related to current advances in chemistry. Perhaps such a program could also provide cooperative research opportunities in industry.
8. Advanced Chemistry courses. This differs from the first proposal which was an organized program leading to a degree. The Advanced Chemistry courses would not be designed for transfer purposes but would be directly related to the area of chemistry teaching in the two-year college. They would help teachers keep current by offering programs which stress new discoveries, techniques and theories but not in a specialized and restrictive way characteristic of regular graduate courses. These courses would have to be properly paced and well organized so the attendees would have time to absorb the useful ideas in such a way that they would be useful in their home institutions. The courses must present an overview of current trends and concepts in the subject matter field.

9. A two-year college chemistry center. This would be a center that could study the problems in the programs of the two-year colleges. It would allow the faculty member to come to a central point and engage in seminars or review of materials and become better acquainted with the host institution and its programs and problems and perhaps engage in related studies.
10. A Chemical Information Center. This would be a source of information for literature and personal resources of knowledgeable individuals to which faculty members can turn when serious questions arise.

Without going into other characteristics, details or obstacles, it seems obvious that no single institution can implement all of these suggestions. However, any effective program would probably have to have several of these programs on the campus to which an instructor could come and satisfy some of his specific needs.

A JOB DESCRIPTION FOR A CHEMICAL LABORATORY TECHNICIAN IN A COMMUNITY COLLEGE CHEMISTRY DEPARTMENT

William T. Mooney, Jr.
El Camino College

Summary of Duties

Under the general supervision of the chemistry administrator the chemistry laboratory technician provides the necessary technical assistance to the chemistry faculty and administrator to support the chemical instructional program. The duties of the chemistry laboratory technician may be described in terms such as: preparation, distributing, storing, maintaining, repair, care, ordering, inventorying, budget preparation, calibration, cleaning, construction, supervision, etc.

Examples of Specific Duties

1. Receives, inventories and stores all scientific supplies and equipment required for the chemistry instructional program. Supplies include chemicals, glassware, porcelainware, plasticware, and other small laboratory apparatus items. Equipment includes scientific instruments, models and other capital outlay equipment.
2. Prepares standard stock chemical reagent solutions, special chemical reagents and dilute solutions for faculty and student use.
3. Sees that the proper chemical reagents, solutions, other laboratory supplies, models, charts, equipment and instruments are ready for use at specified places and times as required by faculty and students for their lecture experiments, demonstrations, laboratory experiments, and special projects.
4. Constructs, assembles, adjusts, tests, cleans and repairs instruments and apparatus used for lecture experiments,demonstrations, laboratory experiments, and special projects.
5. Dispenses equipment and supplies from supply rooms to students as required by laboratory experiments. Receives temporarily loaned equipment from students at end of experiments.
6 Establishes, with approval of department administrator, list of fines to be assessed for equipment breakage or loss.
7. Keeps records on assessable equipment checked out to students and prepares statements for student equipment breakage or loss.
8. Disassembles, cleans, and resurfaces metalware equipment items which tend to corrode when exposed to laboratory fumes.
9. Equips and assigns student laboratory drawers and lockers at the start of each term.
10. Keeps the laboratories, supply or stock rooms, preparation rooms, lecture-demonstration rooms, and any special purpose facilities in assigned area in orderly and neat condition.
11. Notifies chemistry administrator when any assigned facility or equipment is in need of repair or attention beyond that which the laboratory technician is responsible for or capable of performing.
12. Receives recommendations from chemistry faculty and administrator for new instruct-

ional equipment and supply items and prepares list of such items to be requested in annual budget including required quantities, description of items, specifications, catalog numbers, and estimated prices. Forwards list to chemistry administrator for review with faculty and inclusion in budget.

13. Receives information from chemistry faculty and administrator on curriculum and enrollment and other changes in requirements which would affect annual restocking of inventory. Prepares list of items required to restock departmental inventory including required quantities, descriptions of items, specifications, catalog numbers, and estimated prices. Forwards list to chemistry administrator for review with faculty and inclusion in budget.
14. Takes annual departmental inventory of supplies and equipment and maintains a continuing up-to-date inventory during the year.
15. Prepares, stores, and dispenses unknown samples for student laboratory investigations according to faculty specifications.
16. Supervises and coordinates the work of all student laboratory assistants assigned to those spaces and courses within his jurisdiction.
17. Receives instructional program needs for laboratory-type supplies, equipment and instruments from faculty members and analyzes these for problems and conflicts. Reviews such problems with the faculty concerned and the department administrator, if necessary, who are responsible for resolution.
18. Operates scientific instruments and laboratory apparatus used in chemistry laboratory and lecture experiments and demonstrations such as analytical balances, spectrophotometers, pH meters, and other optical and electrometric devices required to make the necessary measurements and determinations associated with the preparation and analysis of reagents, solutions and unknowns.
19. Fills and labels reagent bottles.
20. Demonstrates initiative and resourcefulness in the management and improvement of function relating to the use of chemical laboratory and other scientific instruments, supplies, and equipment.

Desirable Qualifications

1. Knowledge of:
   a. The laboratory equipment and supplies found in the general chemistry, first year, organic, and quantitative-instrumental analysis chemistry laboratories of community colleges.
   b. The basic principles and laboratory techniques of chemistry as found in the general chemistry, first year, organic and quantitative-instrumental chemistry courses of community colleges.
   c. The safety requirements necessary to observe in operating and working with the chemical and equipment required in community college chemistry programs.
   d. The principles and techniques of supervision and training.
2. Ability to:
   a. Supervise and train student laboratory assistants (and other laboratory technicians in large departments) in the performance of skilled chemical laboratory work.
   b. Perform major repair, overhaul and calibration of complex scientific instrumentation and equipment.
   c. Work independently on a variety of assignments requiring technical skills.
   d. Perform budget preparation duties.
   e. Set up, modify, devise, service, adjust and make minor repairs to apparatus and equipment.
   f. Perform and supervise the performance of issuing and receiving of apparatus and supplies, and maintenance of related records.
3. Experience
   a. One year laboratory experience comparable to the duties described above (student laboratory experience may satisfy this).
   b. Experience in industrial or clinical as well as college chemical laboratories would be suitable.

4. Education:
   a. Completion of two years of college including general chemistry, organic chemistry, quantitative analysis, and general physics. (Additional courses in instrumentation, electronics, and biological science would be helpful.)

ADMINISTRATION IN TWO-YEAR COLLEGE CHEMISTRY DEPARTMENTS

Ethylreda Laughlin
Cuyahogo Community College

With a continuous struggle for a larger chemistry budget, the questions continuously asked at my school when I want new equipment are:

1. How much does it cost?
2. Do you really need it?
3. Do other colleges have it?

One can always supply information for the first and give justification for the second. To get data for the third, a questionnaire was borrowed from a Southern California Junior College conference and sent to a small number of $2YC_3$ committee members for suggestions and comments. The resulting modified form was distributed at the San Francisco Two-Year College Chemistry meetings and the results tabulated.

Although attendance was high at the San Francisco meeting, there were many teachers from the same schools. Only one response per school was used in the tally (where names and schools were given). Of the 49 colleges responding, not all indicated the number of instruments available and checks were not tallied to calculate the means. Since the majority attending seemed to be from the West Coast, a second copy of the questionnaire (this time with space for name and school) was mailed to East Coast and Great Lakes states schools.

The one hundred replies tabulated from the second mailing are from schools from the following states:

Alaska	2	Florida	17	Maryland	6	New Jersey	4	Unknown	2
Canal Zone	1	Illinois	12	Michigan	12	New York	28		
Delaware	1	Indiana	1	Missouri	9	Ohio	5		

Comparing data from the two sets of questionnaires, one sees only a few marked differences. The reasons for the discrepancies are not known, e.g. pH meters. The percentage stating these are available in the second study was 95% while only 27% of the San Francisco meeting attendees listed them. A few others showing a marked difference are:

	%	%
	Second questionnaire	San Francisco questionnaire
Potentiometers	78	47
Muffle furnaces	54	88
Calculators	35	57

In the second questionnaire, the following equipment was listed as also being available:

Atomic Absorption apparatus (2 schools)
Calorimeter (2 schools)
Electrophoresis equipment (2 schools)
Spectroscopes (2 schools)
Electroanalyzers (2 schools)
X-ray diffraction unit
NMR
Chromatogram scanners
Fraction collector
Instatherm
Hydrogenation apparatus
Amino acid autoanalyzer
Spectranal
IBM 1620
CRT's
DDP computer
Fully equipped nuclear science lab for radio chemistry course
Scintillation detector
Dry box

Except where indicated, these were listed by one school each.

Of the 96 schools reporting the total budget for supplies and equipment, actual amounts were listed for a few under $2000 and nine above $10,000. The rest merely checked the range as requested. There doesn't seem to be any correlation of the amount budgeted and the fact that new laboratories are added. The highest budgets were for existing laboratories while many adding a laboratory had budgets of $2,000 to $4,000.

Seventy schools reported travel expense allotments. These ranged from zero to $500 per chemistry faculty member. Some did not specify an amount and gave answers such as "varies", "no specified amount", "no limit". These could not be tallied. A few stated that although the budget was made out according to the wishes of the group, in most cases the teachers take turns attending national meetings.

Second Questionnaire (1968)

Schools reporting: 100

Report from questionnaire to Junior Colleges predominantly in East and Great Lakes states.

Other Useful Data:

1. Size of school 2,050 mean. (100 Jr. Colleges)
2. Size of chemistry staff (100 Jr. Colleges)
   3.29 a. Faculty (range 1 -- 14)
   0.38 b. Secretary
   0.44 c. Full time laboratory and/or stockroom - preproom help.
3. Chemistry budget (supplies and equipment)

Budget	No. of Colleges Reporting	% (96 Colleges)	
to $2000	31	32.29	($600, lowest figure given)
$2000 - $4000	24	25.00	
$4000 - $6000	13	13.54	
$6000 - $8000	8	8.33	
$8000 - $10,000	10	10.41	
$10,000 - above	10	10.41	($37,000 highest figure - $23, 673 average of nine)

New Laboratory? 35 Yes 25 No
No. of Labs 2.03 (33 colleges)

4. Travel expenses
   $92.51 average allotment to each faculty member (70 schools reporting)
5. Student help.
   a. Laboratory 2.42 (48 colleges) 37 report help available
   b. Clerical 1.14 (21 colleges) 22 report help available - no number given
6. Have you ever submitted a project application for NDEA funds? 45 No
   Accepted 25 Rejected 2

EQUIPMENT AVAILABLE FOR USE IN OR FOR CHEMISTRY LABORATORIES

Schools Reporting: 49 - First Questionnaire (Western States Only)
100 - Second Questionnaire

Equipment mean was calculated only from reports where numbers were listed

Equipment	% that have equipment *	 **	Range **	Mean *	 **
Calculators	57.1	35	0 - 10	1.6	0.79
Centrifuges	93.8	99	0 - 23	7.0	5.59
Cloud Chambers	44.8	35	0 - 4	1.6	0.58
Conductance Meters	32.6	34	0 - 6	2.0	0.56
Dishwasher with Distilled Rinse Water	10.2	7	0 - 1	1.0	0.06
Drying Ovens	87.7	99	0 - 8	3.0	2.41
Electric Heated Steam Baths	30.6	18	0 - 40	2.1	0.97
Explosion-proof Refrigerator	30.6	23	0 - 2	1.1	0.25
Fisher-Johns Melting Point Apparatus	48.9	33	0 - 4	1.6	0.55
Flame Photometry Equipment	32.6	19	0 - 3	1.0	0.22
Gas Chromotography Equipment	61.2	39	0 - 2	1.2	0.54
Grating Spectrograph	24.4	24	0 - 2	1.5	0.43
Heating Mantles	53.0	44	0 - 180	18.3	7.70
High Vacuum Pumps	59.1	38	0 - 3	1.4	0.91
Hot Plates	87.7	96	0 - 60	10.4	7.73
Ice Making Machine	51.0	56	0 - 2	1.0	0.43
Lathe & Workshop	12.2	12	0 - 1	1.0	0.06
Magnetic Stirrers	91.8	79	0 - 18	7.3	4.89
Microcombustion Furnace	4.0	3	0 - 1	1.0	0.03
Microscopes	42.8	60	0 - 250	3.4	12.65
Microscopes, Polarizing	18.3	21	0 - 12	1.4	0.50
Molecular Model Kits	79.5	98	0 - 72	16.8	9.61
Muffle Furnaces	87.7	54	0 - 4	1.5	0.89
pH Meters, Line Operated	93.8	95	0 - 18	5.3	3.09
Polarograph	26.5	20	0 - 3	1.1	0.28
Polarimeter	44.8	35	0 - 2	1.0	0.39
Potentiometers	46.9	78	0 - 8	2.6	1.47
Rate Counters or Scalers	71.4	62	0 - 10	2.3	1.63
Recorders	67.3	44	0 - 15	1.7	1.16
Refractometer, Abbe	51.0	50	0 - 2	1.1	0.32
Refractometer, Fisher	12.2	20	0 - 4	1.1	0.24
Shakers, or Mixer (e.g. Vortex Genie)	14.2	35	0 - 3	1.4	0.35
Single-Pan, Automatic Balances Analytical	93.8	86	0 - 15	4.9	3.88
Single-Pan, Automatic Balances Top Loader	57.1	45	0 - 14	3.3	1.57
Spectrophotometers, IR	38.7	37	0 - 2	1.0	0.36
Spectrophotometers, UV	40.8	34	0 - 3	1.1	0.36
Spectrophotometer Visual Range	77.5	70	0 - 9	2.6	1.83
Standard Taper Glassware for Organic	81.6	66	1 - 80	22.5	14.67
Vacuum Tube Volt Meters	51.0	51	0 - 24	3.2	2.64

* Refers to first Questionnaire ** Refers to Second Questionnaire

CHEMICAL NEEDS FOR CLINICAL MEDICAL LABORATORY TECHNOLOGY

Lora Allred
University of Utah

(A Summary of Recorded Remarks.)

Ten years ago laboratory instrumentation based on sophisticated electronics was only in its infancy. Currently, the medical technologist is required to evaluate and develop procedures for routine clinical diagnosis utilizing all types of analytical equipment. Many potential alternatives are presented for each type of biological measurement and these must be evaluated carefully and competently. Automation is appropriate for many measurements. Because of these changes, medical technology has become an emerging profession. As instrumentation and methodological approaches become more sophisticated, educational deficiencies become more apparent.

One of the first problems we encounter is the hiatus that occurs between physicians and the laboratory. This is a duel aspect of a single problem. First, our chief archaic tests continue to be in question. Second, the methodology of new tests is not fully understood by physicians--if at all. Hence the limitations and applicability of these tests are not always evident. Because there is a knowledge gap, which promises to widen in the forseeable future, we feel compelled to train professional personnel to perform complex laboratory procedures and to communicate this information to the physician in a form which could be useful and meaningful in the treatment of patients.

Since the need for more knowledgeable personnel is evident, the question arises about who should receive further education--the physician or the medical technologist. Perhaps the introduction of a Ph.D. biochemist or a master's degree level physiological chemist would be preferable. Clinical pathologists might be asked to fill this role, but currently there is a shortage of qualified clinical pathologists. Pathologists now in the field are required to direct the laboratories, serve as intermediaries in interpreting results, assist in diagnosis, and suggest therapeutic procedures. Ph.D. biochemists might be useful in this capacity, but few of them are trained in the physiological implications of disease. Also, these individuals are primarily trained in research and their interest may or may not extend to clinical laboratory processes. These people probably fit best as excellent consultants on methodology problems, but remain over-educated for the day-to-day laboratory problems. Lastly, we can consider the masters' degree level physical chemist to bridge this gap. This individual's education should include biology, anatomy and physiology as well as chemistry and he must understand the principles of quality control, administration, and have an interest in teaching. If these criteria are met there is no apparent reason why he could not function as well if not better than a medical technologist in the clinical laboratory.

As medical technologists, we are concerned with the communication of the knowledge in our field and developing the ability to assess and apply new chemical knowledge to laboratory development and procedures. When a faulty chemical system exists, the difficulty must be recognized and ascertained. If a medical technologist is unable to predict basic chemical reactions, invalid results may be reported to the detriment of the patient.

The results of a questionnaire distributed to medical technologists in Iowa were published recently. This survey was conducted in an attempt to determine the effectiveness of various courses in the medical technology curriculum. Medical technology students were asked to rank the physical and biological science courses in terms of usefulness. Biochemistry was considered to be the most useful subject, then analytical chemistry, microbiology and inorganic chemistry. Pathology, is a course they used very infrequently. Following these courses are physiology, organic chemistry and botany. Eleven per cent of the respondants advocated the omission of organic chemistry from the college curriculum. This seems paradoxical and is probably related to the difficulty the medical technologist has of seeing the relevance of organic chemistry to him because the reactions studied in college are not related to the professional world.

Can the chemistry curriculum be restructured to include rigorous teaching of the basic concepts underlying the chemical tests used in the clinical laboratory? This indeed would be a revolutionary innovation and would require a grouping together of the clinical technician, the scientist and the educator. An approach of this kind would develop an educational program that would prepare professionals to relate what was taught in the academic world to what is encountered in the professional world. This is a task that could neither be accomplished by the medical technologist alone nor independently of him.

Another area in which students are deficient is solving mathematical problems in chemistry. The following examples should provide some feeling for the problems medical technologists must be able to solve. What is the pKa of acetic acid or what is the pH? What happens when ionization occurs? If commercial sulfuric acid has a specific gravity of 1.84 and contains 98% sulfuric acid, what is the normality? If the presence of a unknown sample is determined by color development and its optical density is 0.425 while the optical density of a 5% milligram standard is .50, what is the concentration of the unknown assuming that Beer's Law applies?

It is important to note the terminology used here of five milligrams per cent. This terminology is confusing to chemists who have presumably straightened out the problem and it is an Achilles Heel in the laboratory. In 1966 several international organizations made recommendations for the usage for specific quantities and units. These recommendations have been published by the Williams and Wilkins Company but they have not been accepted into clinical pathology. A national committee for clinical laboratory standards has been established to study this problem. This committee has identified areas where standards are essential and where standard specifications are desirable.

There is a real need for basic chemistry preparation adapted to medical technology. The needs of the health community are highly specific. There are interrelationships between chemistry and other disciplines in medical technology. An example would be the chemical mechanisms of cells as applied to microbiology. In addition, new analysis for toxigenic agents resulting from pollution and pharmaceuticals must be developed and assays performed. Computerization to handle laboratory data may also become very important in future laboratory development.

CHEMICAL NEEDS FOR CLINICAL MEDICAL LABORATORY TECHNOLOGY
(Critique)

Jerry Flook
Gavilan College

One of our first problems is that only one out of ten of my freshmen students knows whether he wants a pre-dental, pre-medical, pre-medical technology or something else. Even the four-year colleges will find this is true to a great extent. Until students have a chance to do some exploring and until we help them to know what is actually taking place in various career areas, they seldom seriously consider what area is really for them.

The program that has been described varies somewhat from some less stringent and less rigorous programs in medical technology that do exist throughout the country. It would appear preferable to advise the student to be in pre-med right from the start rather than go into medical technology. Differentiation could be delayed until later when the student's interest would be established. It might be desirable to push academically poor students into this field to get them into something in the medical area. This may not be the answer but there has to be a lot of use of particular abilities.

The cause of much of the exodus from the fields that require chemistry is that we make organic chemistry a hurtle. If there is a hurtle, it ought to be removed. Organic chemistry should be taught as a part of chemistry, as a part of the profession into which the student is going. Organic chemistry really is not any harder than any other chemistry. Artificial, psychological barriers are raised because of the refusal to regularily use examples of organic chemistry.

It seems reasonable that if a student is gradually introduced to the concepts of organic chemistry throughout first-year chemistry that it would not be so difficult when he started the second year. There are some things that can be done with nomenclature. Instead of calling acetic acid HAc all the time, determine how many students actually know the structure of acetic acid at the start of class. Acetic acid can be used for problems on equilibrium constants in the freshman year. It has become a practice in my class to stop everytime an organic acid or an organic base is used as a chelate when we get to complexes we look at the structure of the compounds and name them by the different nomenclature methods. The energy diagrams, reaction intermediates and equilibrium problems do not have to be reserved for inorganic examples.

We have been teaching a course that is literally designed for the biological field but it has been a course in inorganic chemistry. Possibly its emphasis should be reversed. This may appear drastic but we do not have many chemistry majors and even they may not be harmed by having organic chemistry in the first year.

Since all types of instrumentation can not be provided, it is necessary to be very selective. The selection may be required to show either infrared, ultra-violet, or NMR--we probably cannot have all three. A gas chromatograph and an atomic absorption unit may be available. These probably should be incorporated into first-year and second-year courses. They need not be reserved for the second-year.

CHEMISTRY AND THE DENTAL STUDENT

(A summary of recorded remarks.)

In 1960 a survey on dentistry was completed by several prominent men from the field of dental education. Essentially the survey said that more dentists were needed. The profession expressed the idea that more dentists were not needed because of the technological improvements in the ability to deliver dental services and to provent the need of dental service. The prospective dental student must ask himself, "Is there opportunity for me in dentistry? Is fluoride going to take care of all the dental problems?"

The GPA (Grade Point Average) specialist has presented an additional problem to the schools of dentistry. With draft deferments being given in the professional schools, we find the GPA's rising and a number of dry fingered dentists being educated. These people are repulsed by the very idea of therapy, treatment and practice. As these individuals question the curriculum, dental schools are undergoing a period of curriculum re-examination. Everything taught must be defended by the lecturer.

As a concession to chemistry, the dentist, whether he realizes it or not, is perhaps influenced more by chemistry than any other discipline. Fluorides as a preventive measure have developed through the knowledge of chemistry. Eighty-two million people in our population today are on fluorinated water supplies and it is reducing their need for fillings and the dentist who is being trained to do those fillings. Streptococci research is being developed to the point where we can inhibit the plank formation of the tooth which causes disease of the supporting tissues of the teeth. Chemical developments are effecting the two major classifications of dental disease, the soft and hard tissues.

The following points relate to the needs of chemistry in dental school:

1. Of the 64 to 72 hours of required courses for pre-dental students, 26 hours are in chemistry (14 in general chemistry, 4 in quantitative analysis, and 8 in organic chemistry).
2. Students are selected for their grade point average rather than manual ability, personality or dedication.
3. Dental schools on the West Coast are accepting a minimum of their students from the two-year colleges. Students at a community college are at a disadvantage as they are considered as two-year college students regardless of the number of years they attended beyond this. It is recommended that the students transfer after one year at a community college.
4. Chemistry is of value to the practitioner as an act of baptism. Dental students must learn to handle stress and chemistry gives them this opportunity. Its main value is in the sciences of dentistry, that is in nutrition, pharmacology and preventitive areas. Chemistry also gives discipline and an introduction to the scientific method. These things are remembered long after malaria, pH, and problem solving are forgotten.
5. Chemistry is a part of the foundation on which other sciences--bio-chemistry, physiology, pharmacology and micro-biology are built.
6. Our dental school encourages completion of B.S. requirements with the exception of upper division science requirements prior to enrolling so that a degree may be obtained after the second year in dental school. Therefore we accept only applicants who have a senior standing upon entering dental school. This forces the student to take non-science courses and thus, broaden his educational experiences. Also, many students change from dentistry to another career. If they have followed the degree program to pre-dental studies no time has been lost. It is an advantage to the student if the chemistry taken is non-terminal and will be acceptable to meeting the requirements of majors.
7. General chemistry in the freshman year is valuable as an introduction to a chemical vocabulary and as a background to other sciences that will follow. During the sophomore year we like to see quantitative analysis with special emphasis on solutions, concentrations, molarity, ionic strengths, pH and buffers.
8. Background information in chemistry should include the following: The structure of matter; atomic structure, chemical bonding, radio-isotopes and radio-activity. Inorganic chemistry; physical chemistry, properties of colloids and collodial terminology. Measurement; spectroscopy, kinetics and equilibrium reaction, equilibrium constants, association constants, and solubility. The concept of pH and its confirmation: weak and strong

acids and bases, neutral salts and buffer solutions. Dynamics. Organic chemistry; nomenclature and the physical and chemical properties of the various classes of organic compounds, amino acids and proteins.

CHEMICAL NEEDS FOR MEDICAL SCHOOLS

Sidney Velick
University of Utah

(A summary of recorded remarks.)

Medical curricula are currently undergoing intensive re-examination for the first time in sixty years. Drastic changes are being introduced at most medical schools. The chief form that these changes take is that the entrance requirements are being made more flexible for several reasons. One reason is that there is a current emphasis on medical practice in contrast to research. Thus it is felt that the science requirements are too stringent and are preventing potentially good doctors from going into medical school. Another important reason for the change is that practising medicine has many ramifications and many specialities. This results in various scientific requirements and the tendancy is to provide a flexible curriculum which will allow multiple tracts for the students to follow depending upon their interests and previous training.

Training a medical student is one part of the responsibility of a medical school's biochemistry department. Its other major responsibility is training graduate students.

When medical students are accepted by the Admissions Committee their grade point average is given rather serious consideration. At Utah, for example, the grade point average of the class is about 3.3/4.0. This might indicate a class of potential geniuses, but this is not true. Some students arrive needing remedial arithmetic, some have forgotten simple chemical concepts and any attempt to teach any regular exploratory course in biochemistry to a freshman medical class is rather frustrating.

There is one rather unexpected reason for this sad state. The requirement for a high grade point average in every medical school causes students who intend to go to medical school to choose snap courses. They find the easiest course that they can take in every subject to increase their chances of getting an "A". This is a practice that should be abolished. This year the University of Utah's Medical School accepted 5% of the class for four years from now from graduating high school seniors with outstanding records. These students will go to college with the idea that they have already been accepted to medical school. Their potential has been proven and they are being encouraged to take courses in which they may not get "A's", particularily in science.

Taking the easiest possible courses is not the only reason for the freshman medical class having forgotten most of its chemistry. A student preparing to enter medicine is encouraged to take a lot of subjects; biology, physics, many social sciences, cultural subjects, and chemistry is simply a hurtle that has to be overcome. Those who know that they are going to medical school still may not have a disciplined interest in chemistry.

Special chemistry courses for pre-medical students may not be frequently given in as many two-year colleges as they are in four-year colleges. It would be very helpful if organic chemistry, for example, was taught from the standpoint of biochemistry. Compounds having biological interest should be used as examples rather than intermediates and plastics. One of the important things in teaching college chemistry to premedical students is to convince them of the relevance of what they are studying to their intended professional career. This means that the teacher of organic chemistry has an obligation to have a rather good general knowledge of biochemistry. He should know where the problems are and what material is of interest.

The medical students who have had a year of organic chemistry, a year of physical chemistry and a year of general chemistry enter medical school with a dismaying ignorance of chemistry. The majority of the class, lack any dynamic or functional feeling for chemistry as it should be seen by a biologist. This cannot be remedied by formula, it must be remedied by the enthusiasm and thoughtfulness of the individual teacher.

A REACTION TO THE CHEMISTRY NEEDS OF THE MEDICAL PROFESSION

George Martins
Newton Junior College

In the preparation of medical school candidates, two-year colleges have not had a good record. The desirable premed training approximates that of a chemistry major. Of prime importance would be successful performance in the principles of chemistry in a physical chemistry course with skills in quantitative analysis and mathematical operations and some knowledge of descriptive chemistry. Suprisingly, of least need would be elaborate study of organic chemistry since biochemistry training in medical school meets this need. Just what kind of physical chemistry can be offered and successfully taught in the two-year college is a question and challenge to the science department at this kind of institution. And finally, in the midst of all this depth training, the physician deals more with people than test tubes and his way of looking at life is very important and requires a good grounding in the humanities.

Perhaps the premedical training is beyond the scope of the two-year college in that the medical student most likely completes two more years of undergraduate training in a four-year institution. However, it is fitting that a solid two-year core of chemistry courses be available for the potential doctor. The following might be features of such a program (which, also, might be sufficient for the chemistry major).

1. A two year sequence of general chemistry and organic chemistry. The former should be a principles course with relevant descriptive chemistry taught within the principles framework. A quantitative approach should attempt some calculations of thermodynamics but avoid the solutions of differential equations of quantum mechanics which will be studied in proper depth in a physical chemistry course at a transfer institution. The organic course should not emphasize biological chemistry since the medical student will get plenty of this later.
2. The first year laboratory should be thoroughly quantitative and should not expand qualitative analysis beyond a few experiments to meet the needs of aqueous equilibria and the excitement of identifying unknowns. Some instrumentation would most likely require pH meters, probably utilize "spec 20's" and in some cases introduce students to the IR machine. Experiments on heats of reactions and a rate law study would be desirable studies the first year.
3. Because of the mass of information on organic compounds the organic course should not be text oriented. This approach to teaching organic has been growing in use as seen in the J Chem. Educ. This approach cuts the monotonous format of traditional courses and should make organic a more exciting intellectual endeavor. However, the motivation requirement for such an approach is high since student preparation before each class is significant.
4. Finally, chemistry should be taught as a humanity (which it is) rather than as a dry impersonal body of knowledge. The instructor is the means to this end, not the text--which has too much to say. And little can be said as to how the teaching of chemistry as a humanity can be accomplished--it is wrapped up in the mystery of the art of teaching. Personal enthusiasm for his

subject and continual reference of the subject's relevance to the human condition and its doers, the scientists enshrined in the text, are some of the avenues open to the teacher.

CHEMICAL NEEDS FOR PHARMACY SCHOOL

Robert Mason
University of Utah

(A summary of recorded remarks.)

It may be necessary to present a somewhat stronger case for good training in chemistry for pharmacists than what is apparently necessary for medical doctors or for medical technologists. This is reasonable since the pharmacist is concerned with drugs and should be a qualified expert on drugs. He needs to know more about drugs than any other member of the applied health professions.

Drugs or pharmaceuticals may be administered to patients in the form of highly purified, single chemical compounds or they maybe mixtures of two or more compounds. They may be administered in several ways but in order to produce their effects, they must pass through a number of biological membranes. They must be dissolved in body fluids and be transported to their sites of action before they can perform any useful function. The chemical and physical properties of the drugs are functions of their chemical structures and are important in the drug transport processes and ultimately they are involved in the interactions that produce the physiological responses.

The pharmacist should be able to look at the structural formula of a drug, visualize it in three dimensions and then draw certain conclusions on the basis of distribution of atoms and electrons that he sees in the structural formula. He should recognize the various functional groups, predict their influence on solubility and chemical reactivity and recognize potential stability problems so that the proper precautions can be taken to avoid detioration either before or after the medication is dispensed. The inspection of the structural formula, will often allow him to catagorize the drug into its pharmacological class. At least it will allow him to make a educated guess as to what physiological response might be expected after it has been administered.

Thus it should be apparent that a pharmacist has to be a very good chemist. His education should provide a sufficiently through background in basic and applied sciences to prepare him to become an expert on drugs.

In considering the chemistry needs in pharmacy, it may be best to use some illustrations of what is presented to pharmacy students during their three or four years in pharmacy school. It is important to illustrate that the chemical background of the pharmacist should not be confined to persons in organic medicinals, but is important in all of the areas that are involved in the professional training of the pharmacist. The important factor in drug action is the ability of the drug to penetrate various biological membranes and be transported by the body fluids to the receptor site. To explain drug penetration and transport, it is necessary to consider the chemical ion, equilibria, pH and pK, activity co-efficients, solubility, the influence of acidic and basic functional groups on solubility and on the transport process. The subject of the size of drug losses is important--this is its affinity for neutral fat deposits in the body or binding with plasma proteins or tissue proteins. The relationship to these factors to delaying or prolonging action of drugs due to their slow release is emphasized. These factors also include hydrogen bonding, ionic interaction, etc.

There is considerable pre-occupation in pharmacy courses with relationships between chemical structure and activity. This requires an understanding of physical chemistry.

In these discussions the use of molecular models is a great help and models are invaluable in training students to think of a drug molecule in three dimensions. The action of drugs is explained on the basis of enzyme substrate interactions, drug receptor interactions, competitive and non-competitive inhibition, etc. The importance of steroid chemistry to structure relationships is repeatedly occuring. Optical isomerism is another aspect of steroid chemistry which frequently enters into the discussion. Many drugs contain centers of asymetry and those that are obtained from natural sources usually occur in the form of a specific structure. Invariably there is a marked difference between the physiological activity of the forms. One of the forms will be the active drug and the other will be much less active or it may be devoid of any physiological activity. It may even have an entirely different effect. In organic chemistry, optical isomers are frequently shown to differ only in the direction in which they rotate a beam of plain polarized light. They are shown to have the same melting point, boiling point, etc. But they certainly differ in their physiological aspects.

Reaction mechanisms are used to relate chemical structure to biological activity. Generally, the exact reactions by which a drug will produce its effects are not known. However, studies using molecular modifications have often made it possible to identify the functional groups associated with a particular biological activity. Another area where a need for a good background in chemistry is required is in organic synthesis. Some people involved in pharmaceutical education feel that the discussion of synthesis should not be included in a course in organic medicinals. Others feel that there are important applications of synthetic techniques that serve pharmacy students after they graduate even though they never carry out a synthetic procedure. It certainly helps the student to understand functional group chemistry. It helps the student to understand and appreciate drug stability, degradation, deterioration and chemical incompatibility. It is difficult to describe the metabolic transformations that occur with a drug to the students who are not well versed in functional group chemistry. The fact that some pharmacy schools are minimizing or eliminating synthesis is a good argument for a good presentation of that subject during the general chemistry course.

A good preparation in chemistry during the first two years of college is important to students going into pharmacy. The basic chemistry courses--including general chemistry, qualitative and quantitative analysis, and organic chemistry--should be the same courses that are required of chemistry majors. They should be taught in the chemistry department and the students should be in competition with chemistry majors. They should be modern, high level, courses which emphasize that science is a process of inquiry, a way of thinking, rather than a collection of facts. Courses that are slanted toward pharmacy by extensive modification of the course content are desirable but should not result in lowering standards of student performance.

CHEMISTRY FOR ALLIED HEALTH PROFESSIONS

Wendell T. Caraway
Flint Medical Laboratory

(A summary of recorded remarks.)

There is an acute shortage of personnel in the 30 to 40 fields of health and medical care occupations. Certain surveys predict that the need for manpower in health areas will be about 10,000 new people per month for about the next ten years or about 1.2 million individuals in the next decade. The U.S. Labor Department has named approximately 100 programs in the health and medical field but many of these are on the aide or assistant level. These various programs include pharmacists, medical technologists, chemists, microbiologists, occupational therapists, physical therapists, registered nurses, practical nurses and more. Many of the new programs emerged from the internal need of medicine and medical schools with health education centers. A number of four-year programs are now underway and many of these have become well established.

A great majority of the relatively new career programs in the health fields are found in the two-year colleges. These programs will be instrumental in providing the needed personnel for the community health services. Some of these new programs include operating room technology, medical emergency technology, inhalation therapy technology, environmental health technology and bimedical engineering.

Colleges preparing to establish the two-year programs in health areas should consider several elements. First, they should carefully consider the state licensing requirements for the category. For example, the state of Michigan licenses clinical laboratory personnel. They will be classified as specialists, clinical laboratory technologists, or clinical laboratory technicians. Anyone who is going to do any laboratory work will have to qualify in one of these catagories.

A second item to consider is the recommendations of the related professional organizations in the field. The American Society of Medical Technologists recognizes the medical technologist. There is the American Registry of Microbiologists, the National Registry of Clinical Chemists, etc.

A third item to consider is the actual nature of the work that an individual performs in the catagory. The type of educational background must be provided that will be most useful to the individual preparing for the career.

At last, the college should make some survey of the community which determines the needs to assist the individual students. Programs frequently start with great enthusiasm but it soon becomes obvious that not enough attention was given to the state requirements of the program or the needs of individuals going into the program.

Good training in chemistry is required by health personnel. Sometimes more training in chemistry is needed than might be expected. A person with a Ph.D. in chemistry may be the supervisor of the clinical laboratory. He provides the basis for confrontation of the medical staff in cases of scientific problems or problems related to biochemistry. He may also have a wide research program. Even small hospital laboratories will contain a wide variety of sophisticated laboratory equipment. There are useful individuals with bachelors or masters degrees that seem to be more oriented to analytical chemistry than to biochemistry who work in clinical laboratories.

There are positions that require more than the general survey courses in chemistry which include training for physicians, dentists, pharmacists, and the baccalaureate degrees for medical technologists. The ASCP, which now calls itself the Registry, requires three years of college plus 12 months of hospital training in all phases of laboratory work. Since the hospital training usually comes in the fourth year, students sometimes do a fifth year after the bachelor degree and the student usually gets three to four lectures a week in the various fields. The Registry now requires 16 semester hours of chemistry. This is minimal and it strongly recommends at least one semester of qualitative analysis to be taken. There are 60,000 ASCP or registered medical technologixts in this country and there are about 38,000 working. There is quite a turnover in this field because of marriage, pregnancy and transfer of husbands. Even though 38,000 are now working, there is still need for more and within the next ten years we will need a total of 90,000 or almost 3 times as many as we have now.

There are two-year programs within the health sciences and these people are not really dealing with chemistry at all. Certainly, there are a number of two-year programs for registered nurses that do not require anything that is related to a course in college chemistry. However, high school or very elementary chemistry courses are very suitable as prerequisites for the two-year program in the allied health sciences.

SAFETY IN THE CHEMISTRY LABORATORY

Malcolm Renfrew
University of Idaho

(A summary of recorded remarks.)

The fastest way to start the safety program in your college is to have a very serious accident in your laboratory. In an amazingly painful fashion, you soon discover how critical people become of everything you have done and how critically your practices are reviewed. Unsafe things will be found in most of your practices if you have had a serious accident. This is not the recommended procedure for starting a safety program. It is unfortunate that a dramatic jolt often is needed to make us safety conscious.

The University of Washington has a safety course which had essentially no chemistry majors in it until there was a very bad accident in the chemistry laboratory. They had a man who lost his arm, much of his shoulder and had damage to his eyesight in a serious explosion. Suddenly they had an epidemic of chemistry majors taking the course. It should not be that way. Emotional reaction should not be required to start safety programs.

I have a historian's perspective on safety in the sense that in my lifetime I witnessed the growth of really effective safety programs in industry. In 1926 there were 32 lost time accidents per million man hours of work in industry. Forty years later, and with much more critical reporting standards and much more reliable reporting standards in the collection of more data, this figure had been reduced for all industry to seven accidents per million man hours of work. In the chemical industry this figure is less than half the figure for all industry. Some chemical companies have excellent safety programs and the figure is less than one lost time accident per million man hours worked.

The people who work in chemical industry now are safer on the job than they are at home. Safety consciousness can be developed and is shown by chemical workers having fewer accidents off the job than other groups.

It was my good fortune when I entered the chemical industry to work for du Pont. Du Pont has had one of the most effective long-term safety programs in the business. When I began work, I did not understand all the rules and grumbled about some of them. We had to wear eye protection all the time and this rule was rigorously enforced. A person could not carry matches. Smoking was restricted to certain areas. There were protective guards over the moving parts of vacuum pumps and all sorts of moving equipment. Use of mouth suction on pipettes was prohibited. Safety cans had to be used for solvents. If a safety can was being filled, the drum from which it was being filled had to be grounded and a wire from the safety can had to be connected to the one that grounded the drum. Even with all of du Pont's concern, accidents still occurred and when an accident came close to me in the laboratory where I was working, safety rules took on even more meaning. I finally appreciated the fact that the du Pont safety program was not a fraternalistic kind of program. It was not a case of big brother watching over us at all. This was a program which met an economic need, accidents cost hard dollars as well as human suffering. The du Pont Company was conscious of this fact.

I think that there has also been an economic motivation in the rise of safety consciousness in universities. Damage suits apply the principle of the deep pocket. The principle of the deep pocket says, "Sue only the people who can afford to pay". In past years teachers were not considered particularily good targets for a suit. But today's college teachers are found to be worthy targets of a suit and more and more suits are occurring.

When accidents happen in a school, a teacher finds that he has real problems and must be able to prove that he taught all of his students good safety practices. This is sometimes a difficult problem. Particularily if they have never been specifically asked, many students will not know that they were taught good safety practices.

In states where school trustees can be sued, it is common for a school to carry insurance for teachers to protect them against suits. These policies will usually protect against liability, unless faculty members have been guilty of faulty practices. However, teachers rarely know to what degree they are protected by the policies in force at their university. I suspect that all of us would do well to get more information about the kinds of insurance we can get to protect ourselves against such liability. Some mailings recently arrived on professional insurance which can be sold to students who are entering the teaching profession to guard them against potential damage suits when they are in school. Coverage can be continued after they graduate.

When starting safety programs, attention is primarily focused on eye protection. There is reason to do this since at least twenty-five of the states now have legislation which says it is essential that eye protection be worn in laboratories. Now the interpretations of these laws is not always easy. For example, it is not always clear in many of those states as to whether the laboratories concerned are simply grade school and high school laboratories or whether college laboratories are involved. The kind of acceptable eye protection is not always clear. Is it simply impact resistent eye protection, or must it be total eye protection which will protect against the splashes of all types of explosions? The ACS Safety Committee has been developing recommendations for the kinds of eye protection that should be sufficient for what happens in chemical laboratories.

Although safety rules have been published by various groups, including the Advisory Council for College Chemistry, there has been no tidal wave toward the explicit teaching of safety rules. A number of people now ask students to sign a set of safety rules. At the University of Idaho, students receive two sets of rules. The student keeps one set and he returns the signed statement that he has read the rules to the instructor in the course. This is enforced in our freshman laboratories and some of the instructors in the upper division laboratories are using this approach.

The set of instructions which we have was sent to a law professor who said that one could not be sure about the legal significance of this approach protecting a teacher against a liability suit. Certainly if a student had signed and was under twenty-one, this has no legal significance. The law professor drew the general conclusion that it certainly helped to prove that a teacher was interested in safety practices, that he was going to try to enforce safety practices and that the students really had been told something about the necessity for safety in the laboratory. Thus I do recommend this approach to you on that basis.

Membership in the Campus Safety Association is recommended. This is an organization which primarily consists of the safety officers of each university or college across the country. It is an active group that publishes a monthly newsletter and is affiliated with the National Safety Council. The membership fee is two dollars per year.

The rule that no one is to eat anything in the laboratory or to use labware for dinnerware is a good one. At the current time the H_2S, carbon tetrachloride and mercury problems may not be the critical safety hazards they were in older laboratories. However, there are often genuine safety hazards met in the handling of new chemicals which have not been fully evaluated but need to be handled very cautiously. When new chemicals are used, we need to be suspicious of them. Certainly students rarely develop the consciousness that absence of oxygen is just as dangerous as toxic chemicals. In the courses which I teach, I emphasize that it only takes a couple of breathes of an oxygen free atmosphere to cause people to become unconscious and very soon after they will die. If they fail to die they will have serious brain damage. Explosive hazards are greater in laboratories than are the hazards that are faced with toxic chemistry. The refrigerator that has not been fixed so that it is a non-spark refrigerator is real dynamite in the laboratory. Students fail to appreciate that solvents really are explosive, peroxides can be dangerous and that the clorates are tremendously dangerous.

Common sense must prevail when a really serious accident occurs. When minor accidents occur in our laboratory we want to avoid being guilty of practicing medicine without a license. The victims of minor accidents should be sent to the local infirmary. But when serious accidents occur, we must know that we have to stop the flow of arterial blood. People who have an artery cut can bleed to death in as little time as one minute. That has to be stopped immediately. We have to know how to give artificial respiration and the telephone number of emergency service.

NEW HORIZONS IN THE TEACHING OF FIRST-YEAR COLLEGE CHEMISTRY

James Quagliano
Florida State University

(A Summary of Recorded Remarks.)

There has been a great change in the content of the first year college chemistry course. The trend has been to stay away from the strictest chemistry and move toward physical chemistry in the freshman year. In a limited number of cases, high school preparation in chemistry has been oriented toward physical chemistry. Also the changing content of first year chemistry reflects student-teacher rebellions against the dry, functional approach.

Descriptive chemistry may tend to be theraputic in nature and very few students sit down and memorize the reduction-oxidation equations that would soon be forgotten. Many of our courses leave the details of descriptive chemistry to the laboratory or general discussion. The function, specifically in this approach, would be that the students would learn the facts of descriptive chemistry when they were needed. But teachers, especially those who have been teaching chemistry for some years, know that in many cases there really is basic factual information that the students need. A sound approach to first year college chemistry should emphasize that freshman chemistry is first of all the memorization of facts and the rationalization of these facts on a theoretical basis is essential. Only after the student has been exposed to the basic facts of chemistry will he be provided with the guiding principles which will help him in feedback and also in the naming of elements and compounds.

The student should be aware of and beginning to use chemical bonding and structure. These concepts can be presented in the most meaningful manner if emphasis is placed on the physical significance rather than on the mathematical form. It is not that the principles of energetics or kinetics are impossible, because these can be used very successfully by the beginning student. However, a number of physical and chemical properties will help him find the answer to one of the more fundamental questions of chemistry, "Why did the certain substance from in preference to others and why do the substances react under specified conditions?" Also, "Why are some substances stable and others unstable under comparable conditions?" In trying to answer these questions with experimental facts on one hand and theoretical interpretations on the other, today's chemistry can be successfully presented to the student. Reaction systems which permit applications of many different chemical concepts includes methane--hydrogen chloride, methyl chloride--hydrochloric acid and methane--other halogens. Thorough examination of these reaction systems enables the student to see many aspects of chemistry. This includes tabulated factual information, equations, physical states, properties, structure of atomic size, molecular size, bonding, molecular orbital concepts energetics, bond breaking and making forces, energy diagrams, bond formations between related molecules, entropy, free energy or available energy for the reaction, and mechanisms. This provides a basis to compare any reaction or any compound, which is thermodynamically stable and the reaction conditions so that product predictions can be made. This approach promotes interest of the students and gets them to asking questions of themselves and of the teacher. They ask, "Why do these reactions take place? How can we control these reactions? How can we regulate and change the conditions to get control of the reactions?"

CHEMISTRY LABORATORIES FOR THE FUTURE

G. Tyler Miller
St. Andrews Presbyterian College

(A Summary of Recorded Remarks.)

At a meeting of some fifty to seventy-five chemistry teachers in the state of Virginia, almost all expressed real disappointment with the first semester chemistry laboratory program. This led to some thinking about change even though it might be disastrous. Something needed to be done to generate some excitement and enthusiasm in the laboratory.

Becasue of the appeal of an approach tried by a colleague in physics, my thinking turned toward a type of laboratory station, each of which would be self-contained.

The list of experiments was made very flexible but realistic. Each station was organized so that students did not have to get a thing--it was self-contained. The last thing before closing the laboratory each afternoon was to go back over the lab and replace solutions and replace anything that was broken.

The laboratory program was organized for fourteen experiments and two demonstrations. Demonstrations were scheduled at the Fall break because the school schedule made a group of students have less time in the laboratory. Demonstration is a good teaching technique and students enjoyed the break. The first week was spent going over where things were in the laboratory. Fire extinguishers, safety procedures, glass bins were discussed and the laboratory program was outlined. The class was divided into fourteen team groups of three students or two students each.

After assignments were completed, a list was posted each week assigning each group to one experiment. For example, group one would do Exp. 1, group two would do Exp. 14, etc. There was also a grade from the final examination in the laboratory.

Two laboratory assistants were brought in two weeks before the semester began. They worked by themselves on the experiments that they were going to supervise. Since there were fourteen different experiments, each assistant was given five and the instructor took four. The assistants ran their five experiments and we discussed them in detail.

At the end of each laboratory period, the experiments were written up. The writing assignment rotated among the members of the group. In other words if there were three members in the group, one would do the write-up one week; the next one would do the write-up the next week, etc.

About ten minutes of the laboratory period was used to orient the students to the work they would be doing. After the instructor's four groups were well on their way toward completing their work he became available to talk to the other students. A group that had finished their experiment would come into the office and be quizzed. They were asked questions to stimulate their thinking and determine if they had a real understanding of the experiments. They did!

One of the more stimulating experiments used a gas chromatograph. One day the chromatograph broke down and for the group that was working on that experiment on that day, it was the best thing that ever happened. They got interested and excited about that problem and had a ball finding what was specifically wrong. This is one example of the excitement that was generated. We found that students talked about this program in the dormitories and other places. Students enjoyed the laboratory and had to be driven out at night.

Without being told, students went to the library. I had to put the books on reserve and the students really used them. They could look at the bulletin board and find out about the experiment they were going to do next week. Then they would go to the library to dig out information.

For several years, an evaluation form had been used to rate the teacher and program. The form used a scale of 5--superior, 4--very good, 3--good, 2--fair, and 1--poor. The laboratory had always ended up with a rating of 2. With this program, it now receives a 5.

DISCUSSIONS ON FIRST-YEAR CHEMISTRY COURSES

The following results were obtained from questionnaires distributed to attendees of the Regional Meeting in Boston. Twelve colleges are represented.

1. The maximum size of lecture sections varied from 30 to 150 students with slightly more than half of the colleges having a maximum of 50 students or fewer. All but two of the colleges limited the size of the laboratory sections to 24 students or fewer. Most of these students were freshmen, although two colleges had approximately equal numbers of freshmen and sophomores.
2. The most popular text, by far, was Chemistry, by Sienko and Plane; used and commended by nearly half of the respondees. The laboratory manual accompanying the above text was used by one-quarter of the respondees, with Frantz and Malm's Principles of Chemistry in the Laboratory being about equally popular. Schaum was the most popular problem workbook, although a number of others were also recommended. Supplementary paperbacks, such as Barrow, and films were indicated by some as being useful.
3. Although one-quarter of the colleges devoted an entire semester to qualitative analysis, the consensus seemed to be that six weeks or so was enough.
4. Slightly more than half of the colleges indicated that a full-year course in organic chemistry was offered, while slightly fewer than half offered at least one semester of quantitative analysis. Slightly fewer than half offered, in addition to their course oriented toward science majors, a lower-level chemistry course for non-science majors.

While it might be risky to assign great statistical significance to the above information, it at least gives some impression of the orientation of the group at the section meeting.

General discussion produced the following results.

I. Size limitations for first-year courses. How large should lectures and laboratory sections be?
   A Types of arrangements used in small schools (less than 100 beginning chemistry students).
      1. Three lecture groups
      2. Large lecture groups
   B. Types of arrangements for laboratory sections.
      1. Majority of teachers have the same group of students for lecture and laboratory.
      2. If some teachers have only laboratory supervision assignments they feel subordinate to the teachers with lecture assignments.
      3. Some schools use second-year students as teaching assistants in the laboratory. General agreement that these students must be selected with care. Suggested that such students should have a background in physical chemistry before they assist in freshman laboratories.

II. Difficulties in determining prerequisites for first-year college chemistry courses. Problem of what to do with students with a weak high school chemistry background, or none at all.
   A. Follow-up study of failures in chemistry at one institution showed that failure correlated more with ACT English scores than with any other of the considered variables.
      1. Students must be able to read and reason to succeed in college chemistry.

    2. In most high school chemistry courses almost all the information given students is transmitted by the spoken word. Students have had little experience with having to read directions. Reading practice is necessary for some students.

  B. Should you be able to teach chemistry to those students who have had no high school chemistry?
    1. Should these students go into the same classroom with students who have had high school chemistry?
    2. Tests show that high school chemistry students do better on the first examination, but by the second one all students do equally as well.
    3. At some institutions students can test-out of the beginning chemistry course. Different policies are used for giving credit for the successful completion of these examinations.

  C. Repetition of material included in high school chemistry.
    1. Is repetition necessarily bad?
    2. Many students learn by having a second exposure to a concept.
    3. Reverse trend by adding more material at the freshman level that is new to students.

  D. Selection of a textbook for the first-year course.
    1. Are the new books on the market suitable for first-year courses, or are they more appropriate for a physical chemistry course?
      a. Some new books are an imposition on the first-year student.
      b. "High-level" texts should be made available to interested students.
      c. Student who cannot use "high-level" texts still make good technicians and chemists.
      d. Teachers must be selective about the material they elect to cover in their courses.
      e. Possibility of not using a text at all was suggested.
      f. Books should be treated as references not as the outline for the course.

III. How much physical chemistry can be taught, or should be taught to first-year students who have had little exposure to physics and calculus.
  A. Physical chemistry has a special place in the first-year course because of the applicability of the general principles of physical chemistry to all other areas of chemistry.
  B. Junior college teachers worry too much about whether the courses they teach are "respectable." They should be more concerned about matching the level of difficulty of the material to the abilities of the students they are teaching.

V. Relationship of laboratory and lecture grades.
  A. Colleges in which laboratory is graded as a separate course--none of the colleges represented in the group.
  B. Laboratory grades usually count between 25% to 33% of course grade. In several institutions, if the student fails laboratory he fails the course.

A SOPHOMARE LEVEL CHEMISTRY COURSE FOR BOTH MAJORS AND NON-MAJORS

John Kice
Oregon State University

(A Summary of Recorded Remarks.)

Chemistry teachers, being chemists themselves, are prone to teach for the benefit of those going on in chemistry rather than the vast majority of their class. They ought to recognize that most of their students are never going to actually practice chemistry and the important thing to do is to enable them to see chemistry as an exciting, vital and interesting way to spend one's life. In doing this chemistry may even find a few converts.

In many larger institutions organic chemistry is taught in two separate courses, one designed specifically for the chemistry major and the other for the non-major. There is a tendency in some schools to place the pre-medical and biological science students in the majors' course because of the serious amount of organic chemistry they should know. The result is a course where time is spent concentrating on subjects relevant to the chemistry majors while the pre-medical students develop a justified aversion to chemistry. The real excitment of the course is lost in the details, which can later be developed for the chemistry major.

Is it possible to teach a course which will enable the chemistry student to continue a four-year chemistry course without being penalized and yet, teach the non-chemistry majors--pre-medical students, dentistry students, biological science students--without either boring or overwhelming them? I feel this can be done if the basic concepts of modern organic chemistry are stressed and the number of specific examples of those concepts are minimized. If there are students in the course who are clearly going on in chemistry, they can be provided with supplemental work, particularily in synthesis. This is an area that the chemist may need to know, but the non-chemistry major does not.

The course for non-chemists taught at Oregon State is one model of a course that seems to do the job. This is a year course of only two lectures a week. In many places it would be the equivalent of a two quarter sequence except for the lectures of the first half of the course. The classes are divided into small recitation sessions where we can drill the students on working specific problems and check whether they are getting the principles presented in lecture. The biggest problem of organic chemistry for students is not in understanding the concepts as much as in applying the general concepts to a specific case, in doing the problems. In these small recitation groups the students can be assured of getting off to a good start and keeping up. We put off laboratory work until the last half of the course and then have six hours of laboratory. By this time the student knows enough chemistry to incorporate the basic techniques into more interesting experiments. To avoid insulting the students by using a cookbook approach, modern techniques with inexpensive equipment such as simple gas chromatography, column and vapor chromatography and spectroscopic methods for identifying unknowns are feasible. If simplistic experiments are done, try to work out multi-steps where the product of one step is used for the next step. This impresses upon the student the necessity of obtaining a high yield in each step if the experiment is to be commercially feasible.

We begin our course with a review of freshman chemistry, atomic orbitals, ionization, etc. No matter how sophisticated the freshman course, the students can forget a lot over the summer and it is well to spend a little time to make sure that they are on the same frequency with you. At this time we introduce nomenclature, the structure of different types of compounds and a few of the most important reactions. Mechanism and stereo chemistry are left out at this juncture to enable the stu ent to concentrate on one type of thing at a time. After the foundation is built, we can talk in a more sophisticated fashion. With this background you can introduce a little synthesis. If you teach this before the student knows many reactions, he can concentrate on the essence of an organic synthetic problem--how to build up a carbon skeleton and place the functional groups at the right position without pondering over which reaction to choose. Other important concepts covered include MO theory, electron de-localization and the confirmational analysis--particularly of the six membered rings.

During the second third of the course we introduce the effect of structure on reactivity mechanisms by considering aspects of acid-base equilibrium. This is a good time to introduce this as most students understand equilibria and energetics more easily than the energetics of actual reaction mechanisms. Also, elementary reaction rate theories and behavior of the key intermediates in organic chemistry are discussed. At this point, we repeat a survey of all different types of organic reactions. We create a general picture of how things are done, show how specific reactions appear with respect to knowledge today and fit them into the generalized picture. If we are able to create pigeon holes for the students through giving them the general principles they are well on their way toward understanding the concepts behind the reaction. In this third of the course we also present some reactions with molecular rearrangements.

We begin the third part with a discussion of different types of aromatic substitution from a mechanistic viewpoint. Emphasized are the use of mechanistic principles, energy, stereo chemistry and rate contest. The last two-thirds of the last third of the course is open for special topics. Usually we fill this time with topics for the biologically oriented person. We introduce spectroscopic means of identification of structure, carbohydrates and genetics.

THE FIRST COURSE IN ORGANIC CHEMISTRY TODAY

Ronald Pike
Merrimack College

(A Summary of Recorded Remarks.)

The responsibility of discussing the topic of organic chemistry for two-year colleges is an exacting one since it encompasses the "basic training" in this area for a large number of students. Some students will go directly into industry; others will go on to further education in a college or university offering a four year program in chemistry. Thus, an appropriate balance must be achieved. One approach of viewing the over-all topic is to discuss the "HOW" of the problem: How much? How presented? How retained?

How much? Since World War II the subject matter in organic chemistry has undergone an explosion. A look at a typical basic organic text such as Morrison and Boyd, Noller, Roberts and Casserio makes one wonder how all that material can be covered. My answer is "you don't, and more over you shouldn't". Another question is "Should aliphatic chemistry and then aromatic chemistry be presented or should an integrated approach be used?" What place does laboratory work have in the over-all two-year program? How heavy and demanding should be the laboratory work?

The following guide lines are offered:

1. Emphasize basic principles. Study the main classes of compounds. Certainly, a student must have knowledge of the acids, amines, aldehydes, etc.
2. Use the least possible amount of memorization. Some memorization is necessary. The language of organic chemistry is entirely new to the majority of students and like any language they must memorize the alphabet. Organic nomenclature and structures are basic to an understanding of what organic is all about: But memorization must proceed beyond this point, too.
3. For a two-year school we urge a three semester sequence of organic chemistry.
    a. Three semesters of organic with qualitative organic being integrated into the laboratory program.
    b. Two semesters of beginning organic plus one semester of qualitative organic.

I am particularly enthused about the role of qualitative organic in the training of students. This is where the student puts into practice the theory he learns in lecture. He sees, feels and struggles with the "unknown". This is where he actually gets his hands dirty.

How presented? Several avenues are available for presenting organic chemistry.

1. To solve the aliphatic--aromatic or integrated presentation, the material may be arranged around the mechanistic approach. Basically there are four types or organic reactions: substitution, addition, elimination and rearrangement.

Once a student is grounded in nomenclature, bonding, structure and especially stereo chemistry of the carbon atom, the basic presentation can be centered around mechanisms. In this way memorization of individual reactions is kept to a minimum If the student is shown why the reaction goes the way it does and how it proceeds mechanistically, he can then predict the course of many reactions he has never seen Most important in this type of approach is the presentation of the stereo chemical aspects of the reaction sequence.

The use of visual models becomes important. A student retains much more when he sees a visual picture of what is probably taking place. The students who have trouble with organic chemistry are not able to visualize in their minds what actually is taking place in a reaction (as far as we know). The use of the mechanistic approach following bond breaking, bond making and especially tracing the changes in spatial geometry that the molecules undergo is essential in this area.

As sequences are discussed in the classroom, perform them in the laboratory:

1. A nucleophilic substitution on a saturated carbon atom.
2. Electrophilic substitution on an aromatic compound.

But reactions for the sake of reactions or straight technique experiments (which are necessary) are insufficient. A purpose must be attached to the experiments to give the student an incentive to solve a problem. Example: Dehydration of 2-butanol with H_2SO_4 olefins. Collection of the olefins. Determination of the composition and ratio of products. Use VPC: 1 butene, trans + cis butenes--ratios + relative amounts. Experiments of this type are important because it brings an awareness that organic is not an isolated area. Here it is combined with analytical chemistry. Example: Dehydrobromination of 2-bromo butane with KOH. In doing this study the kinetics. This seems very well to bridge the physical chemistry--organic chemistry gap.

Furthermore, the qualitative organic laboratory either as a separate course or integrated, is essential since it:

1. Develops the concepts of reactions by functional groups.
2. Makes use of instruments such as IR, and UV but still requires the student to get his hands dirty.
3. Develops the concept of reaction sequences in synthetic preparation by derivatives.

How retained: How do we assure that the student will retain the material? After all, this is our main objective.

1. Leave the trimmings to future training. Give the student something on which to grow.
2. Visual aids are important to the idea of seeing what happens. Use demonstrations that picture a color change, an explosion or a precipitate. These pictures remain long after the words are forgotten.
3. Talk to the students and try to get close to them. Talk with the students about what they are doing. They come to us with questions but do we go to them?
4. One last item is very personal. If we cannot work up enthusiasm for the organic chemistry course which we teach, how can we interest others?

ORGANIC CHEMISTRY FOR THE TWO-YEAR COLLEGE

William Brown
Beloit College

(A summary of recorded remarks.)

The Curriculum Committee of the Division of Chemical Education has been divided to form subcommittees for the various areas of chemistry, including organic chemistry. The Organic Chemistry Subcommittee was presented a very fine outline for consideration at a recent meeting. It was discussed at length in terms of what would be the full package of information for the first course and what would represent about 80% of every first course. This approach would recognize that there are many things that can be included but would encourage each instructor to handle it as he pleased as long as he included a minimal contact. Our goal when teaching a course should not be necessarily to provide a sense of accomplishment in our terms as organic chemists, but should be directed to what our students must know and what we would like for our students to attain from the course. We need to objectively look at the question of what do we want our students to do that they have not been able to do before.

With this kind of thinking in mind, a set of behavioral objectives began (and continues) to be considered. This approach appears to have some very effective uses and may become much used in the future. Generally, the teaching of organic chemistry is in pretty good shape. There is considerable agreement on what should be done and what lies ahead.

In the course being taught at Beloit College, the first regard is to organic chemistry even though the course is also for the pre-medical and pre-dental students. The chemistry in this course has been chosen to tend toward the area of biochemistry. There is good reason for this since the vast majority of persons enrolled in this course are there because the chemistry supplements or complements the life science courses. This permits attention to be focused on chemical transformation instead of on straight synthetic chemistry. As a result, the initial reactions of benezene has been deemphasized and there is greater concentration on the reactions of acids, alcohols and the hydrocarbons. The reactions of various carbohydrates, phosphoric acid (as it applies to organic chemistry), amines, amino acids and enzymes are studied. Reduction-oxidation is used and half-reactions are written.

CHEMISTRY FOR NON-SCIENCE MAJORS

Harris Van Orden
Utah State University

(A Summary of Recorded Remarks.)

What should the non-science major know about chemistry? This is an age-old problem and will continue to exist for a long time. The nature of science has changed and programs must be continually reassessed in terms of the needs of students, demands of the subject matter and the interest of the teachers of science. The importance of this subject continues to increase and is more important today than ever before because of the great need for scientific literacy by the general population. The public needs to be sufficiently aware of modern science and free of misconceptions. It needs to be better prepared to make value judgements that are too important to be left entirely in the hands of experts. The limitations of the expert's methods and approaches to problems must be understood.

The curriculum is but one dimension of determining <u>what</u> chemistry for the non-science major. The Advisory Council of College Chemistry and other groups have beckoned to this call and discovered important questions. What does one build the curriculum around? What should be omitted? How can the curriculum present the growing science and simultaneously do justice to the quality of the courses? Actually, the subject matter is not the real problem.

Another dimension centers about the fact that the student clientele do not conform to a simple classification. Students in humanities and arts, business, social sciences and education must be included. It may include all those students not clearly majoring in chemistry, physics, biological sciences, engineering, agriculture, home economics, forestry, clinical chemistry or industrial technology.

An interesting question was recently posed by some teaching assistants after their first year as assistants in a contempory natural science course for nor-science students. The teaching assistants asked, "Why is it that a course for non-science students makes an effort to point out the way scientists actually work and assignments are made on topics that are never mentioned in regular science textbooks or courses that science students get? Is it not even more important for the future scientists to get such considerations early in our careers?" Why do we never teach our regular science students anything about science except for technical subject matter? We really need to stop and think about this.

A third dimension is suggested by the difficulty teachers have in determining the best way to meet the challenge. The teacher--scientists have widely varying committments and abilities but must communicate selected material in a meaningful--relevant way. No set pattern or narrow spectrum of communications can be applied, only guidelines which are subject to change and mofidication. Experience must tell each of us what is the best means of "doing our thing." Teachers must have enthusiasm for significant knowledge. Evidence of this trait may be shown by avid reading of informative books or journals and keen observation of natural phenomena. Each teacher must also have a second quality, the urge to communicate. The question is, "Do you really want to communicate with your students or is it just a job that you have to do?" A good teacher uses the art of communication, but it requires the establishment of rapport between the transmitter and the receiver. The ability to communicate can be developed.

Most non-science students are enrolled in chemistry because of a requirement. It is either a stated requirement in the departmental program or a general education requirement.

At Utah State University, the chemistry course is under the category, Exact Science. The student sees this and thinks that he will be given all the answers. When they fail to be given exact answers, they become extremely frustrated because they are expecting to get an exact answer to everything.

We must not be concerned about topics. We must be concerned with getting to the essence of chemistry. The problem is in the variable, students who present themselves in trying to implement an answer in a relevant way. The variables are the students, the teacher or teachers and the subject matter. All of this must be mixed together into a smoothly running operation to get the job done. Too often, one or more may dominate the program and significant emphasis is not placed on all three variables simultaneously.

Chemistry, like any science, has many facets. One major facet is referred to as science of search and places emphasis on the edge of scientific knowledge or research. Another major facet is science as publication--the consolidated part of science. Both facets are essentially proper in the development of science. However, scientists in general tend to ignore science as being consolidated and favor viewing it as science research.

Many non-science students find much satisfaction in the laboratory. By making proper selections, this portion of the program can support the lecture portion.

There are conflicts between the basis for science and other elements of the educational pattern. There may be a need for fragmentation which would lead to various special interest groups. (This would at least produce smaller classes, more personal contact and maybe a better atmosphere for learning.) This does not mean that the basic approach to chemistry must be changed. Different examples must be selected but they can be made rigorous and a good job can result.

The movement toward larger and larger classes is a situation of the educational process brought on by the sciences. In the four-year college and universities this is frequently caused by the desire of the staff to provide more time for their real interest in science research. This situation provides a real problem--an economic problem--to new staff members. A new university staff member who thinks he is going to spend his time teaching is mistaken. If he wants to get ahead economically, he must keep his eyes open and not spend too much time teaching. The approach must be, "I'll do a good job of the teaching available, but I'll negotiate and see that I don't have very much of it."

The large classes are supposedly justified on a cost basis, but it is a bit frustrating that the teacher cannot really get to know anyone in a class of 250 or 300 students. This may not be a cost factor so much as it is a desire to reduce the teacher's time in teaching. The university needs to conduct research as well as teach but these two functions of the university must be recognized.

Students may accept at face value the cliche, "The hope of the world lies in the students". A 1958 report, "The Public Influence of Student Character," showed that students felt that America's concept of higher education was not sufficiently in tune with the rest of life nor was it genuinely relevant to their concern. Because of this lack of relevance, students tend to regard the four years of college as a parenthesis within which they can enjoy themselves, possibly for the last time before maturation really occurs. The parenthesis encloses something which has no particularly striking relationship to what went on before or to what will follow. At that time (1958), students had a studied pretence of indifference beneath which was a searching desire for meaning in all that they did. At that time, the student was also protesting individually that he should have an increasing opportunity to think and act for himself. One student was quoted, "They keep telling me that college is a preparation for life but I'm alive now."

For today's students, this difference, this belief, instills a spirit which in their dress and behavior seems shockingly provocative. They are a product of the gradual lowering of the age level of sophistication due to a change in their preparation. The traditional goal of earning a great deal of money as a mark of success has lost all of its charm. Today's students are aware of the misery in the world and want to remove it. Now they enter college hoping to learn how to cope with the world and improve it. Of course, they still need to learn something to make a living. Too often, they picture science as contributing only to the latter goal. They do not picture science in the way most of us would prefer to look at it--that of a challenging, delightful, intellectual experience that lets us enjoy the reality of the world around us.

The image of science is rather poor. However, there are many examples that could be brought to the attention of students to show that science has done much for the world and will continue to do so. It can be sold.

Non-science students, in fact all students, face an increasing dilemma in studying science today. Too many courses are still taught between the disciplines of chemistry, physics, zoology, etc. I don't see many that are truly interdisciplinary. Disciplines tend to remain separate in their development and are isolated from each other.

Because of the growth of specializations, fragmentation occurs within the discipline. In an attempt to overcome this fragmentation, new subject matter and more general principles which encompass larger and larger parts of science are developed.

More and more abstract concepts are introduced into our teaching. Students are therefore expected to know more principle and fewer details. I don't think that we ought to mislead ourselves into believing that the two are the same. As much may have been lost as gained in moving toward greater and greater abstraction. That is what is done when proceeding from less sophisticated to the more sophisticated theory. It now encompasses more material, but it is more abstract.

There are many students who have a difficult time understanding abstract things. More time is spent in the humanities trying to clarify abstract concepts than is done in the sciences. When we go from valance bond theory to crystal field theory to molecular orbital theory, there are large jumps in abstraction level. There are many people who don't grasp abstract concepts easily. If they are to learn, they much be taught the significance of the abstractions.

The need of the technologist may not be met. He is certainly a non-science major to whom the application of science rather than the consolidated part of science is more important. Has the science curriculum become too mathematical as well as too abstract? Some of our well-known geniuses of chemistry are referred to as non-quantitative geniuses. Mathematical ability is not necessarily a prerequisite for success in understanding things. Perhaps this should be kept in mind and the mathematical approach more carefully examined when developing the programs for the non-science majors. Much understanding of science and a good deal more understanding of the scientific enterprises could be reached without increasing the emphasis on the mathematical concepts. It must still be recognized that a student does have to realize the importance and the scope of quantitative methods and their contribution to science.

It is said that a course in science for the non-scientist should be valuable in giving understanding of and (hopefully) permit the experiencing of the art of experimentation in the elaboratory of theory from observable facts. Do teachers or does the curriculum today provide this experience or is it concealed in a maze or disembodied abstractions of theoretical superstructure? Is overemphasis given to the phase of science concerned with research because this is the primary interest seen in our university program? Does this fail to help the student, the future citizen, gain an insignt into the application of science? Does our program provide an overall broad outlook which will meet the aim of science education?

A program in science should be advocated for all students, irrespective of whether they have professional goals that require it or not. About eighty percent of the students change their professional goals from the time they enter the university till the time they leave. A recent study of the Merit Scholars showed that sixty percent of them said that their professional goal was in a science field when they entered a university. Only twenty six percent of them finished in science. This poses the question, "Who is the non-science major? There may be a need for a course for people at the undergraduate level which deals with science as such.

Science courses should not have to serve as a filter. It is very common for seniors to report to non-science chemistry courses every spring. They come in and say that they have to take chemistry to graduate. They should be told to go back and tell their college's dean that chemistry will not stop their graduation. The only reason that a non-science student should not graduate is because his own school will not allow him to graduate, not because he has to fill a chemistry requirement. It should be the responsibility of the various college deans to sell the need of chemistry to their students. It is easy for the chemistry teacher to sell chemistry. However, if the students come in not knowing why they are taking chemistry, they should be asking someone in their own college why they are doing it.

DISCUSSIONS ON CHEMISTRY FOR NON-SCIENCE STUDENTS

Wallace Johnson
Treasure Valley Community College, Oregon

(A Summary of Recorded Remarks.)

For many years, Treasure Valley Community College was saddled with what our big brothers, Oregon State University and the University of Oregon, wanted us to do. The fact was so strongly presented to us that we were forced to use the texts and laboratory books they used. The course outline had to be approved by members of their staff. In fact, one course I wanted to teach was refused because a staff member and the Science Curriculum at one school felt that it was not sufficient. That is probably good when a new college is starting. We now feel a little more freedom since most of the junior colleges are community colleges.

I like the statement that emphasis should not be on covering a whole textbook, but rather on each teacher doing his thing. I think I could do something differently than someone else and that is just what I would like to do in order to be an effective teacher.

I define the non-science majors to include such students as those in nursing and agriculture. In our area, at least, a tenth of our students are agricultural majors. They tend to take non-science courses.

Non-science chemistry teachers should try to emphasize journals, but I really wonder how much a non-science major gets out of a journal, even a journal such as Science and News Weekly or Science? I think they have too much difficulty in reading it. Scientific American and Chemistry are good for the non-science major. Although Chemistry is supposed to be written for high school students, I must confess that my students have difficulty reading it. However, they do like to read it.

The trend at our school is to have larger classes instead of smaller ones. We used to say that one of the advantages of the community college was the close relationship between the teacher and the student. However, the chances of this happening are being reduced as classes are getting larger.

Everybody has his thing that he does best and I think I know what my thing is. My best thing is answering questions that the students raise. I feel that I am doing my best job of teaching when I can get them to ask me questions on what I have been studying lately. However, I had a section of 92 this last term and I just had to say, "We'll never get anywhere if you're all going to ask questions."

This approach is very effective in our non-science program. I quite often spend two to three hours in the laboratory situation working problems and answering questions. Obviously this cannot be done in lecture.

Sometimes we create some of our own problems. I am grateful that the people who designed our science building designed our lecture halls for a maximum of 48 chemistry students. However, I see a room over here that has 333 seats.

I also do not think we can listen to our students. I taught for four years before going to Treasure Valley Community College. This is the first year that I have really felt that I had some top students. Whether we want to face it or not, for an experiment. He came back the next day and asked to do the experiment again because he thought it was fun. The next day he walked into the laboratory and said that his friend wanted to see how the experiment worked. Soon his friend asked if he could register for chemistry since he dropped history to be in the chemistry class. This is unuaual!

We have a tendancy to over-program. We start writing a script and the tendency is to put every step into it. We put in every step on the first experiment. They are told how to hold a beaker and everything else. By the time we get to the tenth experiment, we simply say, set up your equipment, do the experiment, turn off the Autoscan and when you are through, come back to the office and we will discuss it. Every Monday the student has to submit a report.

We are finding that the seminars are excellent. Students really like them. We give students a problem sheet which they work at home. If the student is having trouble, he sits down at the Autoscan and goes through a program that tells him step-by-step how to do the homework problem. The students like this and seem to be doing better on tests.

USE OF THE COMPUTER TO SOLVE CHEMISTRY PROBLEMS

R. P. D'Onofrio
Franklin Institute of Boston

(A summary of recorded remarks.)

Simple problems in gravimetric and volumetric analysis can be solved easily with the aid of a computer with the most interesting applications of this tool being in the area of instrumentation. Some typical applications are as follows:

1. Chloride determination by the use of the conductivity bridge. The data is fed into a stored program and the computer tells which line the data best fits. In this case two lines (one before the equivalence point and one after) are obtained and the volume of standard silver nitrate solution used in the titration is obtained by having the computer solve the simultaneous equation.
2. Spectrophotometric determination of the percentage of iron in a sample by the use of orthophenanthroline. A stored program is used to obtain the calibration curve and the other programs are organized to evaluate the quantity of iron.
3. Simultaneous determination of chromium and manganese in a steel sample from spectrophotometric data. Two equations are determined with the computer and then the equations are fed back into the computer for the solution.
4. Develop a plot of EMF vs. Volume of standard ceric solution used in the titration of a ferrous solution.
5. Determination of beta particle range and maximum energy by the Feather method. Computer stored programs are used to determine the shape of all curves.

There are many and varied uses of the computer in the chemistry field and these illustrations should have given you a better idea of how the computer can be utilized to teach a more effective course in chemistry.

going over problems.

We can now divide the students into twelve per section. The students can be grouped to have similar interests such as medicine, chemistry, biology, etc. This allows us to talk about the ramifications of each unit in small groups and emphasize matters that are of specific interest. I think this approach builds enthusiasm much more than if we just walk into a classroom, throw some problems on the board and say that this is the way to calculate pH and away we go.

The approach to the laboratory is to allow the student to come in whenever he feels like it and spend as much time as necessary to do the experiment. The laboratories are only open from eight until five at present, we plan to open them from six in the morning to ten at night in the future. The laboratories are now manned by two girls who are available to assist a student who needs help.

Seattle now has a learning resources center, but originally we were going to use a tape recorder and a slide projector. Anyone who is just starting is advised to do this type of thing. As a matter of fact, it is possible to get some inexpensive recorders or players at $29 to $30 each. Cassettes are nice because they are in a single unit and the student can snap them in without having to thread or rewind them. Then an inexpensive carrosel projector can be obtained at $45 to $55 each. Thus, for less than $100 per unit, learning stations are provided to let you begin work. Sophisticated and expensive equipment can come later.

We located a device that shows slides and plays a tape. It is called the Autoscan. We hired a full-time person to make slides. The first man did not do a satisfactory job and is being replaced. We then made slides ourselves and these are now being used.

The device is rather convenient since there is only one cartridge. The cartridge will hold up to two-hundred and forty-five slides at one time on 16mm film. It will hold up to 45 minutes of audio tape. Thus, there is one cartridge for a student. It can be played at the back of the classroom, a button pressed and the student is on his own. The disadvantage of this unit is that the cartridge is closed. If slide number three should be eliminated, the cartridge must be opened, the slide cut out, the film respliced and returned to the cartridge.

The slides must be arranged according to a script that must be prepared ahead of time. If a good strip is prepared, there is no worry. If it is a bad strip,--. Our original master recordings sounded like they were made in an echo chamber. Thus, we had to build a special room for recording.

An impulse is put on the master recording. This permits us to take the student to a point where he must stop, possibly to set up some apparatus. The program stops and leaves on the slide that shows the apparatus and the way it is supposed to be set up. The student then sets up his apparatus, presses a button and continues. There is also another signal that must be put on the tape. The two signals are used to synchronize and advance the slides with the audio tape. On one side of the cartridge, we have up to 245 slides and on the other side a 45 minute audio tape.

We feel that we have had a great success with this. We had one student who had the distinction of failing chemistry at Olympic Community College, University of Washington, Cornell and Purdue and once from us. He tried again when this program became available. He came to the laboratory and checked out a plastic vegetable bin that contained everything he needed such as thermometers, pipettes and the cartridge used "with a grain of salt" and to be scrapped when better models are developed.

MULTIMEDIA EXPERIENCES FOR A TUTORIAL APPROACH TO GENERAL CHEMISTRY

Herbert Bryce
Seattle Community College

(A summary of recorded remarks.)

Our concept for a tutorial approach to chemistry instruction is drawn from a study done in the State of California. Some of the more perplexing statistics showed one college graduating 27 chemistry majors with BS degrees and 50 chemistry Ph.D.'s at the same commencement exersize. A survey of the records showed that four years earlier they had 3600 general chemistry students. It seemed that something was wrong if less than one per cent of the general chemistry students got chemistry degrees. Regardless of what is taught, it would appear that at least one per cent of the students should become genuinely interested in the subject matter area.

Looking at these statistics and my own teaching, I discovered that I wasn't happy with my teaching. I would stand in front of a class and talk to the kids like an authority. Then I would hope that they could give me something back on a test. At that point I started looking around and talking to people. I stumbled across some interesting articles on instruction and started pulling things together. At this point, I began developing a program at my school in California. Before much had happened, I was invited to Seattle Community College.

To implement the program at Seattle, we had to justify it on an economic basis. We told the dean that we had fifteen contact hours per instructor and the normal load would be one lecture of three hours per week and two laboratory sessions of six hours per week--giving a total of fifteen contact hours. We then took the twelve hours of laboratory time and the three lecture hours and broke it down to five three-hour sessions. The old system would give contact with sixty students. Now these sixty students could be distributed among five sessions of three-hours each and give five sessions with twelve people. Thus, there would be no additional cost. We then added six thousand dollars for somebody to run the laboratories.

Our basic concept is to use anything possible to put across the laborious segments of information that must be given to students.

A good example of putting this concept into practice is provided by pH. We are all frustrated with the kid who does not know what you are talking about when you mention logarithms. You then proceed to spend an hour just figuring out logs that pertain to pH problems. The next day is spent on some pH problems. Then another day goes to some sample calculations of equilibrium. Now, three hours have been spent on pH and you look at the schedule and decide that no more time can be spent on pH. The student has now been introduced to the concept of pH but many people would like for students to know how pH is going to be used in the body or elsewhere. We have not got time for that. All we have time to do is draw on the board and work some problems.

What we are trying to do is to make the work covered in the three lecture sessions into homework. This homework must be done before the student comes to a particular session--pH in this example. He may use slides and tapes to learn how to do logarithms. If he knows how he does not bother with that unit of study but goes on to the next step. Now we can use those three hours really talking with the students rather than can present the complete picture to our students at an early point.

These are just a few of the problems when one over-literalizes models. We must realize that reality is always more complex than the model depicts. Correspondence with experimental facts, the ability to predict experiment findings is the ultimate critera of a good model.

The second negative aspect of models is overly conservative This is an aspect of science which is essential, truth must be present before a new fact or a new theory can be presented. Thus over-conservatism, failure to be ready to accept another model is a real hazard which may befall all of us. The failure to keep looking for a new model can defeat science and can defeat teaching. Some of the instructors in organic chemistry still hang on to the resonance theory as an explanation for ground state behavior for aromatic substitution. People like the generalized ideas. This is a new statement to you I am sure, but it occurs in styrofoam as well as in politics.

Although positive aspects of models are certainly more obvious that the negative aspects, there are several aspects which should be discussed. There is a beautiful statement: "Models illustrate, clarify, implement understanding, allow and indeed often encourage prediction." They really can be justified--by one or more areas of chemical knowledge. Would you wipe away your sophistication and forget that you have seen a model before. Pretend you are an art or history or a humanities student and look at this simple, ridiculous bit of wood, balls and pegs hung together. With a little bit of apprehension, how much can be read out of this simple, utterly oversimplified representation of a most complex aggregation of electrons, neutrons, and protons with interactions such that there are problems that never will be exactly solved. With the model, think how much can be read out of it in one immediate glance. First, the specific number and types of atoms in the single unit is demonstrated. Matter is discontinuous, and this the model shows from the beginning. It is not a random bundle of atoms and it is not an aggregation of atoms moving around at random. It is patterned and spa ially formed. It is patterned in a very special way; it is not a plane, it is not as flat as a pancake. Among the predictions that can be made from the model are the number of isomers and the kinds of isomers which are possible. A more subtle type of isomer is the mirror image isomer which consists of mirror images which are not so different in physical properties and not at all different in chemical properties. The mirror image type of isomer can be predicted by the simple-minded model of balls and pegs. When substitution occurs, it usually occurs at a point where there is already something. To those of you who are playing along with me and are an art or a history major, this is sensational. Why should a new atom come in at one point and not at another one?

The models used in chemistry are enormously creative. They are not to be worshipped but neither are they to be scorned. The validity of models is found from experimental evidence and chemistry is still an experimental science. When we use models we do so not because we love arts and crafts work, but because these things represent experimental data and calculations or correspond to data. They represent more to us than do the hypothetical models. The ease of comprehension not only on our part but on the part of our students is the reason for using models in place of mathematical expressions. Students ask why one orbital is spherical but the other orbital is not. Why are there eggs in one book and spheres in another? From this small example, you get the idea of how readily the physical picture influences the observer.

Models can be easy to use and they can be helpful. They are not just valuable, they are invaluable for clarifying mathematical expressions, to aid understanding of complex phenomena, both static and dynamic. However, they must be taken as abstractions. They are not idols or icons to be worshipped, but they are tools to be used, to be

LECTURE MODELS - WHY AND WHY NOT?

Frank Lambert
Occidental College

(A summary of recorded remarks.)

Don't take any symbols, don't take any models too seriously. Don't mistake the symbol for reality. Unconsciously we come to associate the symbol, the model, the image, the map with the actual thing, the actual territory.

How does over-identification of the map or the model, how does this over-literalization of the model hinder our students? The model is a symbol, a representation of reality. It need not be styrofoam and it need not be mechanically moving. For example, an abstraction which we all use to show stability is the inert gas shell for which other atoms strive by losing or gaining one or more electrons (if we are not careful to avoid that ridiculous humanizing of the atom). We frequently confuse our students by over-emphasizing this stability. Certainly it is not the cause, certainly it is not the goal for which each atom strives. The tendency of atoms to become ions and go toward the inert gas shell configuration is not the secret. The secret is the tremendous amount of energy involved, for example when sodium and oxygen combine to form a crystal lattice. It is perfectly valid to emphasize certain facets with models, but we should know when we over-emphasize. We should know when we exaggerate or when we over-emphasize. We must realize how much we exaggerate by the use of examples and students must recognize what you are showing by that exaggeration. Exaggeration is done in various parts of life and should be permissible in chemical modeling. There are dangers involved, and I think that we should be sensitive to these dangers. (One of these is assuming that the word gets across to the students immediately.)

A space filling model of glucose shows very well that it is a small compact molecule, but it is nearly impossible for the students to see where the atoms are actually located. In this model, we exaggerate the space filling properties. With this model, we can get some perception of the molecule in reality, but the limitations of the model must be stated and realized by the student. The model is not the molecule. Few models can circumscribe the experimental nature of the actual molecule. Model users should be properly humble and properly aware of this fact.

An illustration of over-simplification and over-liberalization of a model is the rotation about a central bond of a molecule of ethlene iodide or something of that nature. Rotation in this particular model is a bit mechanically noisy but not too restricted and occasionally can occur. The student naturally wonders if it does occur? The answer is that it does. The more correct space filling model indicates fairly clearly that restriction does exist. As rotation occurs, the iodine atoms conflict seriously so that the bond must be stretched before there can be any rotation. But in turn, this can be misleading; there is not quite free rotation, size does make a difference. The size can be misleading and two erronious impressions can be derived from this. Molecules are not made out of styrofoam. Styrofoam is resistant and the balls cannot be moved past one another. Compression of the electrical field or compression of the electron volume is possible and does occur. So the first erronious idea is that it is impossible to move one group past another if they are too large. The second erronious implication is that the reason for the lack of free rotation is literally the lack of space occupancy. The complete story here is complex indeed; there is not a really simple statement but there are some statements in which the seeming conflict results in attraction rather than repulsion. I do not think that we

Chem Lab III		Chem Lab IV	
Preparation and Resolution of Optically-Active Isomers	Use of Models Synthesis Precipitation Equilibria Iodimetric Titrations Visible Spectroscopy Optical Rotation	Synthesis & Characterization of an Orano-Metallic Compound	Precipitation from Homogenious Solution, Grauimetry Complexation Colorimetry Infrared Spectroscopy NMR Spectroscopy Cryoscopy Chemical Literature
Kinetics of Enzymatic Reactions	Enzymatic Reactions Michaelis-Menten Kinetics Colorimetry Computers	Unknown-Qualitative Analysis	Ultra Violet Spectroscopy Infrared Spectroscopy Nuclear Magnetic Resonance Emission Spectroscopy X-Ray Diffraction
Isomerization of Maleic to Fumaric Acid	Isomerization Reactions Equilibria Elimination Reactions Catalysis Gas Chromatography	Another Sequence to be developed	Potentiometric pH Titrations

Conceptual Goals for Labs I - IV	Labs
Acid - Base Theory	I, III, IV
Biological Oriented Systems	III
Buffers	III
Computers	II,,III, (IV)
Equilibria	I, II, III, IV
Evaluation of Data	I, II, III, IV
Extraction	I
Gravimetry	IV
Kinetics	II, III
Optical Rotation	III
Redox	II, III
Spectroscopy (Qualitative)	
Emission	IV
Infrared	I, III, IV
Nuclear Magnetic Resonance	
Ultra Violet	II, IV
X-Ray Diffraction	IV
Spectroscopy (Quantitative)	IV
Stoichiometry	I, II, III, IV
Titrimetry	I, LLL

Laboratory Techniques for Labs I - IV	Labs
Chromatography	
Gas	III
Ion-Exchange	(IV)
Thin-Layer	(IV)
Distillation	II, III, IV
Gravimetry	IV
Potentiometry	(I), IV
Recrystallization	II, III, IV
Spectroscopy	
Beer's Law	IV
Emission	IV
Infrared	II, III, IV
Nuclear Magnetic Resonance	III, IV
Ultra Violet	II, IV
Visible	II, III
X-Ray Diffraction	IV
Synthesis (Inorganic-Organic)	III
Titrations	
Acid-Base	I
Precipitation	II
Redox	III

Chem Lab I

Unlabeled Bottles	Observation Deduction Chemical Reactions
Heats of Solution and Reaction	Nature of Dissolution Thermodynamic Qualities Acid - Base Titrations Equilibria
Separation and Indentification of a 3-Component (Organic) Mixture	Acid - Base Theory Equilibria Liquid-Liquid Extraction Distillation Recrystallization Derivatives Melting Points Infrared Spectroscopy (pH Titrations) (NMR Spectroscopy)

Chem Lab II

Study of the Reaction between $S_2O_8^{--}$ and I^-	Redox Iodimetry Kinetics & Mechanisms Catalysis Complexation Evaluation of Data Computers (Calculus)
Unknown Chloride, $CatCl_m \cdot nH_2O$	Cation Qualitative Analysis Precipitation Reactions & Titrations Absorption Indicator Equilibria Evaluation of Data (Potentiometric Titrations) (Conductometric Titrations)
Visible Absorption Spectra of Transition-Metal Complexes	Transition Metals Nature of Color Chemical Model: Ligend Field Theor Visible Spectroscopy

DISCUSSION ON AN INTERDISCIPLINARY COURSE

General Comments

The laboratory portion of a two-year interdisciplinary science program at Northern Arizona University was discussed in detail by Professor Donald D. Gilbert. The organizational structure and interrelations are best described by the following tables.

Operation of an interdisciplinary program is difficult. Its success requires a dedicated and unified staff or the supposedly interdisciplinary course simply degenerates to a large number of parts of regular courses. However, the successful operation of the program at Northern Arizona has been found stimulating for both the staff and students.

Instructional materials are critically deficient for this type of program and extreme demands are made upon the instructors. It is possible that a textbook will develop from the Northern Arizona program in the near future.

The Interdisciplinary Program
at
Northern Arizona University

Typical Path for Student with High School Chemistry and Algebra

Majors - Pre Med, Etc.

Semester	Lecture	Lab
1st	Chem Physics (3)	Physics (1)
2nd	Chem Physics (3)	Chem Lab I (1)
		Chem Lab II (1)
3rd	Inorganic Descriptive (2)	Chem Lab III (1)
	Organic (3)	
4th	Organic (3)	Chem Lab IV (2)
		Biochem Lab (1)

Non-Majors

Lecture	Semester
1st Year Chemistry (3)	1st
1st Year Chemistry (3)	2nd
Organic (3)	3rd
Biochem (3)	4th

UPDATING ELEMENTARY AND JUNIOR HIGH SCHOOL TEACHERS

Edward Fohn
Green River Community College

A desire to meet community needs prompted Green River Community College to undertake a program in science for local elementary and junior high school teachers. The target population was those people who had been out of school for ten or fifteen years.

The first major difficulty encountered was providing acceptable credit for the course so that the teachers would have a tangible reason for attending. After negotiation, the school district superintendents agreed to accept this work as credit toward a fifth year of work for the teachers even though the courses were not accepted by graduate colleges. In spite of the original skepticism, biology and zoology were successful and attracted enough students to be offered.

The program was planned for three discipline areas--biology, chemistry and zoology--for the purpose of updating the teachers of lower grades. The primary goal was to help the teachers increase their understanding of what transpires in science today. The work in these courses was distinctly different from the college's normal offerings. The laboratory was made to be something really special.

GENERAL COMMENTS ON NON-SCIENCE TEACHER TRAINING

The problems of teaching chemistry to the non-science teacher is the same as teaching it to other ordinary citizens. These individuals cannot be expected to work easily with numbers. Concepts can be understood. Laboratory exercises can deal with easily observable relationships involving real samples. After the students have actually done something, they can begin understanding it. They must have plenty of time to work on the experiments. Everything should be taken apart and separated into single units and then reassembled. This gives the student a feeling of accomplishment and can be related to the concepts that are being discussed in a classroom. These students should not be distracted by having their attention riveted on mathematical problems. The mathematics can be gently inserted as necessary.

We have a far-fetched theory that we claim to do experimentation in the laboratory. What we should be doing is to enable the individual to have some understanding of the concepts that are under examination. If elementary school teachers can be made to feel more comfortable with science concepts and feel that they know more about it than their students, then they will be able to explain and use the concept better when working with their students.

As chemists, we are trained specifically and are ready to teach all chemistry courses in the time-honored traditional manner. Can we not make a break? Can we not talk about pollution and relate pollution to health problems in a qualitative fashion? Must the laboratory be a horror chamber designed to effectively waste time while teaching practically nothing that will benefit the student? Concepts are difficult to grasp and giving a student a procedure to perform in the laboratory does not mean that he will grasp the meaning or significance of the central concepts involved. Concepts must be explicitly discussed during or immediately after the laboratory work.

we have the lower two-thirds or the lower one-half of the graduates from high school. I am not sure we can listen to what they say and what they think they need. In fact, I think I can do them a service if I almost tell them what they should be thinking on many areas of science through a general, basic non-science chemistry.

Students would rather go to biology, geology and astronomy because they seem to have a little higher level of interest in those areas. Chemistry too long has been too cold, too analytical. I think the trend ought to be including more history and connecting it with the other chemistry content.

I am opposed to the trend of reducing the quantity or eliminating the laboratory in non-science courses. The laboratory for the non-science person, does not have to be the same as that for the chemistry major. There must be some laboratory procedures so that the student gets a more tangible feeling for chemistry. I am not ready to discard the laboratories, but films can be used to good advantage.

The one course for non-science majors that has particularly bothered me is the one for the general education requirement. This general education course should give the student an appreciation for chemistry similar to what the other general education courses are to do for their disciplines. The first couple of years I taught this course I accomplished one thing--establishing a bitter dislike for chemistry. However, I realized what I had been doing, namely teaching the course from a very quantitative approach. The background of the student in general education courses is extremely diverse. There are students in the class who have had chemistry as well as those who have successfully evaded it until they get to college. As a result, it is extremely easy to alienate the student that has tried to evade the science courses if the teaching is oriented to the better prepared students.

We must not put aside the fact that our students are individuals, each with his own personality and abilities. We have the responsibility of trying to stimulate each student that comes to us to the point where chemistry can become a part of his life, even though he may never take another science course. Each one of us is faced with the problem of how to stimulate students to the point where they learn chemistry, become creative and become critical thinkers who are able to evaluate situations and make valid decisions. Since every student is different with different abilities and backgrounds, we must take the student from where he is and build upon that background until he feels some degree of competency in the subject.

Every available means should be used to help the student reach some degree of success. The instructor should forget about being the source of all information and face the fact that there are many, many other sources that can be used to help the students. There are programmed materials that can be used as supplementary aids for those that do not have the necessary background. Both audio and visual tapes should be considered. Places can be provided for the students to use these aids when they need help. The aids can help bring students to the appropriate level. They can also provide additional material for those who want to advance beyond what is being taught in the general chemistry course.

DISCUSSIONS ON INNOVATIONS IN THE TEACHING OF CHEMISTRY

(The following points were made in discussions about programmed instruction.)

Studies of college curricula at Hamline University revealed that chemistry majors spent 33% of their college curriculum and 63% of their college time in the major field as compared to other majors spending 23% of their college curriculum to 30% of their college time in the area of concentration. These data led to planning for more effective use of the students' time through use of programmed texts. The types of programs are:

1. Linear type--right or wrong, goes to next unit if right, if wrong, goes back.
2. Branching type--learner makes response. If correct, continues toward goal; if wrong, follows a different path to same goal.

At Hamline University students in an experimental course study programmed material on a given topic before the topic is presented in class. This initial study is reinforced by class discussion and demonstrations. The students of this group had CEEB math scores of 545 or above last year. At the end of the first semester the class averages on the ACS standardized test were 87 and 85 percentile rank. This compares very favorably to freshman students scoring in the 81-82 percentile rank on the same ACS test after two semesters of freshman chemistry taught by the classical methods the year before. Also an increase in A grades indicated that the good students were challenged more.

At Hamline three types of taped instructional material have been developed:

1. Laboratory procedure tapes which free the teacher from general laboratory instruction for individual help and that can be used effectively by student assistants.
2. Tapes on instrument operations and procedures which free the instructor from the time-consuming routine of teaching each individual separately.
3. Chemical safety lectures programmed on recording tape and 35mm slides to emphasize an important subject which traditionally is taught routinely.

Programmed laboratory instruction is played to the entire class. During the laboratory period of three and one-half hours, all laboratory procedures, background information, and theoretical aspects of the laboratory work are available on tape. The tape is so constructed that students have time to carry out procedures after the instructions are given.

Advantages of programmed learning include:

1. Student studies at own pace.
2. Programs teach by small steps in logical sequence.
3. Technique requires use of question, answer, reinforcement.
4. Immediate knowledge reinforces correct answers and extinguishes errors.
5. Active participation assures continual progress.

Ways in which programmed materials might be used include introduction of topics, supplementation of other non-programmed materials and review.

THE TRAINING OF A CHEMICAL TECHNICIAN

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The industrial researcher who wishes the help of a chemical technician expects to have to teach the technician much of what is needed for the skillful execution of his job. The researcher does not expect or desire the school to teach all the science or all the techniques related to a particular job. Little more than a very basic chemistry, physics, and mathematics background is expected.

The most important part of a technician's training and perhaps the most difficult part to achieve is the development of general laboratory skill. The important elements of this skill are fourfold. The habit of paying careful and explicit attention to details is of prime importance. The habit of carefully observing all results with a particular awareness of the unusual is invaluable. Clarity, completeness, and conciseness in reporting procedures and results must be characteristic of a technician's note-taking. Perhaps honesty is not properly thought of as a skill, but it is probably the most important characteristic of the ideal laboratory technician.

In the curriculum designed to train a chemical technician, practical laboratory work should be highly emphasized. The experiments performed need not be chosen with the idea of exposing the student to the largest possible variety of gadgets. Rather they should be chosen for the opportunity they give the student to develop the skills mentioned above.

DISCUSSION ON CHEMICAL TECHNICIAN EDUCATION

The problems in chemical technology programs centered around three important topics:

1. Curriculum
2. Attrition
3. Recruitment

Comments and decisions regarding these areas are as follows:

1. Curriculum:
   Mathematics and physics are essential to a sound chemical technology program.
   Technical mathematics and physics are preferrable to liberal arts courses and should be taught by math and physics departments.
   The chemistry core varies greatly from college to college in chemical technology programs (24-45 hours).
   Total time available for the program usually varies from 60 to 70 semester hours.
   Regional accreditation (N.E. Region) requires 20 hours of humanities courses which makes it difficult to include as much chemistry and other technical courses as desired.
   Some schools offer a bread spectrum of chemistry courses including general chemistry, quantitative analysis, organic chemistry, instrumental analysis industrial chemistry, physical chemistry and unit operations. Other schools offer only the first four of these courses.
   Local industry should determine which courses are given and which are emphasized.
   Emphasis should be placed on laboratory in chemical technology programs. The same lecture as those for non-technical students might be used but doubling the laboratory requirement is suggested...or emphasis should be placed

on lecture. Use the same amount of laboratory but an additional two hours of lecture per week.

A good technician needs theory as well as practical laboratory experience. He can frequently fall into a self-made slot. If he so desires he can dead-end in a routine work assignment requiring little or no theoretical background. Or he may pursue a more open-ended approach where theory and continued study are important. A good technician becomes a team member and performs many of the tasks of the researcher up to and including the co-authoring of papers.

Laboratory exercises should emphasize the local industrial situation, analysis, inorganic, organic chemistry, etc. Laboratory exercises should be repetitious with the idea of drilling in concepts. Laboratory exercises should closely parallel and reinforce lecture topics.

Laboratory exercises in one school are completely divorced and independent of lecture topics. They are self-contained so that synchronizing lecture and laboratory is no problem.

Laboratory exercises early in the semester are difficult to develop since very little chemical knowledge has been imparted to the student. Some colleges teach only lecture first semester with laboratory starting second semester. Laboratory exercises should stress quantitative determinations and separations techniques. Laboratory exercises early in the year should deal with atomic theory and structure. Students should be taught to observe in the laboratory.

2. Attrition:

In many cases attrition is not due to "flunking out." The student may "transfer out" to another major. In some schools where admissions quotas are placed on programs, students will elect chemical technology (or other technologies) simply because that's where the openings are. They have no interest or desire to be in the program but it is the only way to get into college. These students are considered chemical technology attrition when they transfer to liberal arts in January. Overall attrition in chemical technology programs may run from 50% to 70%.

Orientation programs using industrial trips, guest speakers, movies and film strips may help in stemming some of this transfer attrition. Attrition due to failure can be attributed to intensity and rigor of the program. We're pushing four years of college chemistry into two years of time.

3. Recruitment:

Recruitment aids developed and funded by the A.C.S. or industry could be valuable in attracting qualified students. These should take the form of pamplets, films, film strips and so on.

(Ed. Note: Two publications of papers on education, utilization and recruitment of chemical technicians are available from the American Chemical Society Education Office, 1155 Sixteenth Street, N.W., Washington D.C. 20036. Curriculum materials are being developed through an American Chemical Society project funded by the National Science Foundation. Information can be obtained by writing Mr. Kenneth Chapman, Associate Projector Director, Chemical Technician Curriculum Project, Lawrence Hall of Science, Berkeley, California 94720.)

APPENDIX A

A Collection of five papers presented at the Symposium on Chemistry in the Community Colleges, Division of Chemical Education - American Chemical Society and Chemical Education Division - The Chemical Institute of Canada Joint Conferences, Toronto, Ontario, Canada, May 25, 1970.

CHEMISTRY AND THE TWO-YEAR COLLEGES OF THE UNITED STATES AND CANADA

William T. Mooney, Jr.
El Camino College

It is my pleasure to bring to the chemists of the Canadian community colleges the greetings and best wishes of the two-year college chemistry faculties of the USA.

As chemists we often suggest that the atomic, molecular or aggregate structure of a substance determines its characteristic properties and that these properties determine its applications of uses. An analogous treatment of higher educational institutions may be made. The educational functions assigned by society to a given institution will determine those characteristics related to philosophy, program, and student clientele. These institutional characteristics strongly influence the type of chemistry program found within the college. Therefore to open this first international meeting devoted to chemical education in the community colleges, the planning committee thought it most appropriate to consider the characteristics of community colleges in Canada and the USA and the implications of these characteristics to the development of their chemistry programs. (1)

No single term fits these institutions. In the USA we have found "two-year college" to be the only term acceptable to the varied institutions included within this category, such as the public community and junior colleges; the private junior colleges; the technical institutes; and the centers or branch campuses of the universities. But this term does not fit the Canadian colleges since they include three-year programs in several provinces.

First, let us consider the two-year colleges in the USA,the majority of which are best characterized as open-door, comprehensive, community colleges.

The "open door" means entry into the college is generally unrestricted. It means that many courses and many curricula must be available. Some courses will be within the range of a student's interest and within the purview of his abilities. Some will be outside his interests and some beyond his ability. The student need not choose what lies outside his interest. He should not be allowed to choose that which clearly lies beyond his ability. Unfortunately, many two-year college administrators and faculty do not realize that the open door college philosophy does not require every curriculum and course to be open door. It does require a variety of curricula to match the potentials of a variety of students.

"Comprehensive" means a commitment to a multiplicity of educational functions or purposes. Six functions are generally listed: 1) education for transfer, or the university lower-division parallel function; 2) education for occupational competence, or the career training function; 3) education for living, or the general education function; 4) counselling and guidance; 5) community service and 6) education for overcoming deficiencies, or the remedial or salvage function.

The "community" concept arises because the colleges may be wholly or partially governed by local authorities, they may receive considerable financial support from local sources, they may be tuition-free, or relatively low-cost, compared to other higher educational institutions. Furthermore, they generally respond quickly to the educational needs of their communities, and by the extended day scheduling of classes, they educate and train all segments of the community, from 16 years to 80.

To fulfill the "education for transfer" function a college must provide a well-founded or complete university lower-division college program for persons who desire to continue their education in an academic or professional discipline such as chemistry, physics, biology, engineering, or dentistry. Many students cannot qualify for the university or the state college upon high school graduation, but are potentially capable of obtaining a baccalaureate degree and often a doctorate. In California the university system accepts only the top 12-1/2 percent of the high school graduates and the state college system the top 35 percent. In Florida, which has only a university system, these institutions accept only the top 40 percent. The two-year college must provide an opportunity for the unqualified or ineligible students to demonstrate their capacity to maintain, over an extended period, an acceptable standard of scholarship in subjects of collegiate level, so that they can enter the four-year institutions as fully qualified juniors. Two-year colleges also enroll many students eligible to enter the four-year college directly from high school but who, for various reasons, elect to attend the two-year college and then transfer. (2)

If a two-year college is to maintain college level standards in college-level courses it must be concerned about and maintain the integrity of its transfer courses and program. Therefore, for students not qualified to embark upon a college-level course or program, the college must provide remedial programs. They may be high school equivalent courses for students who possess insufficient skill or competence to master college-level work. (3)

There are three implications of these considerations for the chemistry programs of two-year colleges. First, the college must offer a general chemistry course equivalent to that of the corresponding universities and state colleges. Second, they must offer a second-year chemistry program equivalent to that of these institutions. (I purposely used the term "equivalent" rather than "identical" or "parallel".) The third implication is that the college must provide a means of developing a student's level of performance and understanding so he can enter the general chemistry course with a reasonable chance of success. The Committee on Professional Training of the American Chemical Society has recognized each of these in its recently published Guidelines For Chemistry Programs In The Two-Year Colleges. (4)

To fulfill the function of "education for occupational competence" the college must prepare its students to enter gainful employment upon completion of a two-year course of study and with a reasonable chance of succeeding and advancing. There is currently much interest in and concern about chemical technicians, who are generally classified as being semi-professionals. They represent one part of a continuous spectrum of scientific and technical jobs for which the two-year college must train and educate students. (5) The new Chemical Technician Curriculum Project of the American Chemical Society, supported by the National Science Foundation, will aid colleges in course development for chemical technicians. (6)

This occupational function implies that the chemistry department must also serve the chemical education needs of other occupational groups such as nursing and other health related occupations; engineering technology; cosmetology; fire science; agriculturally related occupations, etc. Because of differences in student background; interest in the chemistry of the field; amount of time allowed for chemistry in the occupational program, etc. This often means a separate and distinct service course for a given curriculum.

The "general education" function requires that we provide general liberalizing education for transfer and occupational students. It also requires that we provide educational experiences of a generalized nature for those members of our community who have neither a higher educational degree goal nor an occupational educational goal.

This function implies that the chemistry faculty must provide or participate in courses or programs designed for the non-science and non-technology majors. These may be chemistry courses or courses given in conjunction with other faculties such as a physical science course; or a general, integrated or natural science course; or an environmental science course or program. In most cases the transfer science major courses or the technology major or service courses are not really appropriate for this purpose.

The "counselling and guidance" function is important because we are obliged to provide a multiplicity of programs for a heterogeneous student body. We have to deal with students who come to us and say "I want to be a chemist, or a doctor." This may or may not be a realistic goal.

The sixth implication for the chemistry programs of the two-year colleges is that they must develop a philosophy and program for the placement of students in chemistry courses at the place where the student has the most reasonable chance of succeeding and where he will obtain the education and training in chemistry best suited for his educational goal. The two-year college situation is such that students should not be allowed to enter a college-level program when they obviously are not ready and will probably "sink". There is considerable evidence that through counselling, guidance and remedial programs large numbers of students can be salvaged and thereby succeed in swimming the whole distance. (7) In the light of this function it is not surprising that there is a great deal of interest among the two-year college chemistry departments in individualized modes of instruction such as audio-tutorial, open laboratories, mini-courses, etc.

The "community service" function requires that the two-year college identify all of the educational needs within the local community, be they highly specialized or general, and respond to these needs by providing suitable educational programs.

A seventh implication for the chemistry programs is the need to develop a series of specialized courses or programs related to chemistry such as a nuclear science course or a water chemistry program, or a science lecture series.

Now, let us turn to the community colleges of our host country, Canada. In a recent publication, The Community College in Canada, Professor Gordon Campbell of the University of Lethbridge describes these institutions thusly:

> "The most significant concept to emerge is that of a comprehensive community college which offers technical and related forms of training, programmes in continuing education for all ages of adult citizens, and courses equivalent to initial university education."(8)

Campbell continues his characterization by indicating that the community college has probably a greater flexibility and diversity in programs, student population, administrative structure, and philosophical base than any other educational institution in existence. He cites the following:

1. Vocational and technical programs of either long or short term, in the trades, industrial, agricultural and semi-professional fields, preparing students for employment upon graduation, and providing the employed with retraining opportunities.
2. University parallel courses in the liberal arts and sciences, usually providing first or second year credit toward a bachelor's degree.
3. Programs in continuing education available in the day or evening, designed to meet the recreational, avocational, or occupational concerns of adult part time students of all ages.
4. A counselling service to assist all students regardless of age in choosing careers, remedying deficiencies, and in preparing themselves as useful citizens.
5. Programs serving groups interested in civic, cultural or recreational improvements of the community.

Some institutions are comprehensive--that is, offer both university parallel and occupational programs - while others are restricted to programs in one category or other. In the Canadian public sector, the specific type of institution tends to be determined by the pattern established by the province. In Quebec and British Columbia the institutions are open door, with standards centered on local needs and community service - much like the American comprehensive community colleges. In Ontario the Colleges of Applied Arts and Technology are divided into three divisions - technology, business, and applied arts - and offer three year programs. Whereas the CEGEPS (General and Vocational Colleges) of Quebec have been established with the idea that all students must eventually graduate from one of these to enter a university, the Ontario CAATs expect only a small fraction of their graduates to enroll in a university and then only on a planned, not an individual basis.

The Canadian community colleges emphasize teaching rather than research and are in sharp contrast to the Canadian universities whose primary tasks are to preserve knowledge; to teach what is known; and to search for new knowledge.

Campbell identifies several trends among the Canadian Colleges which include:

1. The movement toward comprehensive institutions with generalized curricula and away from specialized colleges.
2. An increased effort to clarify the bases of articulation between community colleges, universities, and high schools.
3. Recognition of the value of community colleges as centers where students can reconcile their aspirations with realistic educational goals.

I trust that the above analysis suggests to you, as it does to me, that there is no greater difference between Canadian and USA community colleges as groups than there is among the colleges of the provinces or of the states. We in the USA have found great value in cooperating and conferring across state lines, primarily through the Two-Year College Chemistry Conference of the Division of Chemical Education, and we believe our Canadian colleagues would profit by such a national exchange. (9)

We also believe that the similarities of our chemistry programs and problems far outweigh our differences and that continuing international conferring and cooperation would be mutually beneficial. To this end we invite all of the Canadian community college chemists to meet with USA two-year college chemists to discuss ways in which we might cooperate and confer.

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NON-TRANSFER CHEMISTRY PROGRAMS IN CANADIAN COLLEGES

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Algonquin Colleges of Applied Arts and Technology

Technical education at the post-secondary school level essentially developed in Canada after the Second World War. It was during the 1950"s and, in particular, the 1960's, that Schools of Technology were established in various centres across Canada. These Schools were designed to educate and train young men and women to play an entirely new role in the Canadian Labour Force. They were not designed to prepare students to enter the University but rather to provide them with the education and skills to enable them to function as laboratory assistants in the scientific and engineering environment.

A survey of the Colleges of Applied Arts and Technology, as they are now called in Ontario, and the Institutes of Technology as they are referred to in the rest of Canada, indicates that it is only in the past year or two that the CEGEPs (College D'Enseignement General et Professionnel) in Quebec and some of the new Community Colleges in British Columbia have begun to develop programs that are designed to allow a student to transfer directly into the University with a minimum of time lost in their academic program. I am concerned in this paper with those Colleges and Institutes of Technology whose programs are designed specifically to provide students with career goals as an acceptable alternative to University education.

The Schools of Technology were established to meet the technological needs of our communities. Science had become increasingly sophisticated and thus the day when a Pass B. Sc. was sufficient to enable a person to carry out research activities is long past. Moreover, the talents and creative abilities of our senior scientists were not being exploited because too much of their time was being utilized in routine operations and bench work that could be conducted by highly skilled support personnel.

The raison d'etre in the training of the Chemical Technologist was thus that of educating the post-secondary school student to a point where he could engage in a meaningful dialogue with his laboratory supervisor, understand the nature of the problem under discussion, have the technical competence that would enable him, with a minimum of direct supervision, to set up the apparatus, carry out the experimental work, collect the data and even aid in the interpretation of the results. In fact, the quality of the assistance that many of our graduates have been able to render in their jobs, is reflected by the number of graduates who have been co-authors of papers that have been published. Moreover, personnel officers representing both industry and government have, for some time, been hiring graduates of the Schools of Technology in preference to Pass B. Sc. graduates since the former have a greater breadth of general background, a far more highly developed technical competence and a far greater knowledge of the equipment, instrumentation and techniques used in today's laboratories.

Chemistry programs, in the Canadian Community Colleges, are either two or three years in length depending upon the Province in which the School is located. The programs in the Western Provinces and in some of the Maritime Provinces of Canada are of two years of duration with the minimum requirement for entry being successful completion of senior matriculation, that is, five years in secondary school. Those in Ontario are three years in length with the requirement for admission into the program being a secondary school matriculation certificate, that is, four years of the five year Arts and Science program. To be admitted into the program at Algonquin College, for example, the student must have at least an over-all average of 60 percent in Chemistry, Physics, Mathematics and English in four years of the five year Arts and Science program.

This, basically, is similar to the requirement for entry into pre-science or qualifying year at the University. There is little doubt that in the past, most students who tended to enter these Schools of Technology did so because their High School grades were insufficient to allow them entry into the University. Consequently, this type of post-secondary school education was, for many, another opportunity to obtain skills that would enable them to become economically viable in the community in which they lived.

Programs in Ontario began to evolve on the basis of a core program of English as Effective Communication, Mathematics, Chemistry, Physics, Applied Mechanics with Mechanical Drafting, and a strong course in Electricty and Magnetism. On completing this first year, a student could then move into any one of the Engineering Technologies. Those opting for Chemistry, entered into a program whose purpose was to provide a sound theoretical background in Chemistry and also a high degree of technical competence in the laboratory.

While programs in Chemical Technology are offered in most Schools of Technology in Canada, they often differ in that they are designed to reflect the particular needs of the community in which the college is located. For example, Algonquin College in Ottawa is situated at the heart of Federal Government Pure and Applied Research in the physical sciences. The National Research Council, Defence Research Board, Department of Energy, Mines and Resources, Department of Agriculture, Department of Health and Welfare are only some of the numerous areas of government research and development work in the chemical and biochemical sciences.

Thus, Chemical and Biochemical programs at Algonquin College have been specifically designed to meet the requirements for technical employment in the pure and applied sciences divisions of the Government. Moreover, cognizant of the fact that Ottawa is located between heavily industrialized Montreal and Toronto, its programs also had to be of use to those of its graduates who sought employment in the chemical industries existing in this larger region.

On the other hand, colleges, such as Cambrian College in Sudbury or Northern College in the Haileybury, South Porcupine and Kirkland Lake areas, tailored their programs to meet the needs of the mining and metallurgical industries. Still another example is that of the British Columbia Institute of Technology, in Vancouver, whose chemistry programs reflect the needs of the pulp and paper industry of that Province.

It became evident that industry required graduates with a wide breadth of basic chemical knowledge and an even wider breadth of laboratory experience. Our programs were thus designed to give the students the widest possible exposure to chemical theory and laboratory practice. Emphasis was placed on the basic techniques and common operations used in the laboratory. Advanced laboratories became heavily instrumented since it was felt that industry was looking to the colleges to provide them with graduates who were immediately useful with a minimum of time spent in on-the-job orientation. Since virtually all of the instrumentation being used had electronic components, the students in the second year of the programs were given a thorough foundation in electronics, geared to the needs of the working chemist.

The approach to instrumentation itself was such that the student, as far as possible, would work with specific equipment in a series of experiments. First to study the operating parameters of the instrument, then to relate the operation of the equipment to the theoretical principles upon which the instrumental method was based, and finally to a series of experiments of increasing complexity to demonstrate the application of the equipment.

In addition to the ancillary subjects of English, Mathematics, Physics and Electronics which are continued in the second year of the program, the students become involved with Inorganic Chemistry, Organic Chemistry, Industrial Chemistry and Chemical Engineering Calculations. The second year of the program deals essentially with the basic knowledge and fundamentals of technique that the students must acquire before moving into the more sophisticated aspects of their training. The third year of their program is strongly related, both theoretically and practically, to the kind of laboratory work that they will encounter in industry. Their programs take them into the areas of Physical Chemistry, Analytical Instrumentation, Organic Chemistry, Spectroscopy and Radioisotope Chemistry, again with emphasis placed on technique and the application of basic principles to the instrumentation used.

It is obvious that considerable input was necessary from industry in formulating these programs. Knowledge of current industrial requirements and of the manner in which Chemical and Biochemical technologists would be utilized had to be obtained from industry. As a result of the rapid growth in laboratory sophistication, increased demands were being made on the nature and quality of our training programs.

Not only was it necessary to purchase more diverse highly sophisticated equipment, but the structure of the course began to change quite significantly. Lecture material formerly taught in the fifth and sixth semesters was now pushed back to the third and fourth semesters. For example, the fundamentals of spectrophotometry and of electrometric techniques, both formerly taught in the Analytical Instrumentation course are now being taught in the third and fourth semesters of general Analytical Chemistry in order to leave room for such newer techniques as Atomic Absorption, DTA/TGA and Nuclear Magnetic Resonance. Qualitative analysis is now handled in the second semester of the general Chemistry course and its place has been taken by experiments emphasizing the fundamental techniques of Analytical Chemistry, i.e., the basic analytical operations and the theoretical concepts that underlie these operations.

We have had to diversify our instrumentation so that their use was related to the requirements of the Organic, Physical Chemistry and Biochemistry Laboratories as well as that of the Analytical Laboratory. The heavy demands for persons well schooled in the theory and practice of Emission Spectrography, X-ray powder diffraction techniques, and X-ray Fluorescence spectrography required that we remove these subjects from the general Analytical Instrumentation course and set up a separate course in Spectrography. In a similar vein, we have had to introduce a course in Radioisotope Chemistry to meet the requirements of employers in both the chemical and biological sciences.

We found that it was desirable to introduce such subjects as Theoretical Inorganic Chemistry, not only to provide the basis for further studies in other subject areas, but also to enable the technologists on the job to maintain an effective dialogue with their supervisors. For the same reason most programs will contain courses in Industrial Chemistry and Chemical Engineering Calculations to broaden the technologist's awareness of the scope of chemical industry and to focus attention on the nature of the problems that are routinely solved in chemical industry.

Programs such as that which I have described above are career-oriented and have objectives that are decidedly different from those of the University. While they are designed as terminal programs, they do afford the better student with an opportunity to proceed to further his education in the University. The practice that has been established in Canada is that the superior graduates from these programs are considered for entrance with advanced standing into University on an individual basis and, in fact, many have gone on to obtain higher degrees.

It must be emphasized, however, that while this opportunity is available, this is not the intent of the program. To a greater and greater extent i_ has become evident that High School graduates are looking to the Community Colleges as an acceptable and, in many instances, attractive alternative to University education. The programs offered provide these young men and women with highly desirable career goals and a realization that they will play a significant role in fullfilling the technological needs of the community.

CHEMICAL TECHNOLOGY EDUCATION IN THE UNITED STATES

Kenneth Chapman
Chemical Technician Curriculum Project

Chemical technicians have participated in the exploration and exploitation of the chemical properties of matter for many decades. As chemical research and production began requiring more technically trained people, research laboratories and companies began training chemical technicians for their specific needs. A few high schools and colleges in the United States recognized their potential contributions in this area at the beginning of this century and began to offer specialized programs for the training of chemical technicians. However, real growth in chemical technology education did not get underway until the 1960's.

Late in 1969, questionnaires were sent to all two-year colleges and other institutions believed to be training chemical technicians in the United States. Of some 1,100 questionnaires distributed, 321 were returned. A low response was expected from institutions not having chemical technology programs. Sixty-eight institutions specifically identified themselves with these programs. To this number the author could definitely add 20 institutions that did not respond but which have students enrolled in chemical technology programs. Thus, the minimum number of chemical technology programs in the United States is 88 and it is likely that the total number of active programs would not exceed 100. Of the 68 respondents with chemical technology programs, 56 could identify students specifically enrolled in the program, with an average of 18 students in their first year and 14 in their second year. The 20 colleges added by the author brings the minimum total number of institutions with chemical technology students to 76.

The youthfulness of chemical technology is reflected by the average age of the responding programs--6.85 years. The median of the ages was only 4 years and the range was 0 - 46 years. The 253 responding colleges <u>not having</u> a chemical technology program gave their attitude toward this field by answering the question, "Has your college considered the desirability of starting a chemical technology program?" The replies were:

It has not been considered.	30%
Yes and will not offer.	22%
Yes and still undecided.	32%
Yes and will probably offer.	16%

The latter response group includes several colleges that have set starting dates for the program.

Chemical Technology programs are offered by all types of institutions from high schools to universities. Awards for completion of the program range from certificates to bachelor's degrees. Of the respondents, two were high schools, one was a university with both associate and bachelor's degree programs and the remaining were two or three year programs in two- and four- year colleges.

High school		2	
College level:	4 years	85	(includes 20 programs added by author)
College level:	4 years	1	

The author is familiar with five more high school chemical technology programs that are not included above. There are several colleges and universities offering programs with the flexibility to give the equivalent of a four-year baccalaureate degree program in chemical technology. All of these programs are aiming at a broadly based program in chemistry and a few are making the base even broader by adding biology. One post-high school institution is being developed for programs that will provide in-depth training in specific areas of instrumentation.

Students may soon be in the position of taking a three-year high school program in chemical technology, continuing with an associate degree program and then selecting either a broadly based baccalaureate degree program or a highly specialized certificate program in some area of instrumentation.

Although it will not be discussed here, critical questions must be raised. When is an individual sufficiently mature to make a career decision about chemical technology (or any other vocation)? At what point are we justified in asking a person to make a career choice for a specific field? Are we providing a base that will not become a shackle, but will provide a key to open many doors of opportunity?

One of the extremely important parameters of any career is the standard of living that it will support. The questionnaire response provided starting slaary averages and ranges from two high schools, 22 two- and three-year programs and one four-year program.

STARTING SALARIES
AVERAGE

Program	No.	Average Salary	Median	Range
High School	2	$448	-	$400 - $500
College level: 4 years	22	586	$600	400 - 815
College level: 4 years	1	800	-	775 - 850

Range of Averages for 2-year colleges only $440 - $656

The variations did not appear to have a regional bias except that a couple of programs in the highest cost of living areas had the lowest starting salary averages.

Some of the more disturbing features of the survey centered on the faculty. Many chemical technology programs have suffered grievously because of total reliance upon one individual. The institutions that listed faculty members who taught chemistry for chemical technology had an average of 3.1 instructors each. The range varied from zero for one college that was seeking a teacher to twelve. Not only do many colleges run the risk of the program's destruction because of illness, tragedy or resignation of one individual, but students are denied exposure to a variety of experiences which can only be obtained through a well-balanced staff.

A disturbing lack of industrial or non-academic experience by faculty members was discovered. Although faculty members had an average of six years of industrial experience, many had very little or none as described in the table on the next page.

FACULTY EXPERIENCE

Years of Experience	Industrial	Teaching
0 - 2	47%	22%
3 - 8	27%	46%
9 - 15	16%	20%
> 15	10%	12%

In one institution, an eight-man department had accumulated only two years of industrial experience. That industrial experience should be required is generally conceded and many schools demand up to five years of industrial (or similar) experience.

Faculty members had acquired an average of 7 1/2 years of teaching experience. Individuals most frequently held a master's degree and a relatively small number had Ph.D.'s.

The chemical technology faculty member appears to face several problems (which will not be explored in detail at this time).

1. Although preparing students for immediate employment upon graduation, his first-hand knowledge of the technician's world-of-work is seriously deficient.
2. Being a comparatively recent graduate, he is familiar with the average chemistry or chemical engineering student, but not with the average chemical technology student.
3. As a recent graduate or a continuing graduate student, he has a strong tendency to concentrate on areas of chemistry that have recently commanded his attention and these may not coincide with the needs of the chemical technology students.
4. In addition to his other problems, he cannot turn to a good resource for assistance in developing a chemical technology course or program from textbooks prepared for other purposes.

With these problems faced by the majority of chemic technology faculty, the extremes are represented by two examples: the just-hired faculty member with 30 years of industrial experience who was last in a classroom in 1940 as a student: and the veteran of 30 years of classroom experience who is asked to develop a program but has never seen the inside of an industrial laboratory.

The role of specially designed courses or courses designed for several groups in the curriculum for chemical technology has been the subject of frequently violent discussion for many years. In addition, catalog descriptions are frequently not followed exactly. Respondents were asked to name the textbooks used for the chemistry courses taken by chemical technology students and to indicate if these courses were only for the technicians or for the technicians and others. With 54 colleges responding, 68 percent of the chemistry courses were for chemical technicians only. This number must be used carefully since technical institutions frequently have many more chemistry courses for their aspiring technicians than do community colleges that are using chemistry courses designed for several different groups of students.

Unanimity of opinion regarding textbooks for chemical technology was largely absent. The information supplied by 54 schools is represented in the following tables.

NUMBER OF TEXTBOOKS USED

54 Colleges

	Number of Books Used		Number of Books Used
General	45	Polymer	2
Organic	35	Chemical Engineering	10
Qualitative	7	Industrial	4
Quantitative	23	Biochemistry	1
Inorganic	5	Materials Science	2
Physical	7		

MOST POPULAR TEXTS

54 Colleges

% of Mentions for Course Areas

General - Sienko and Plane (9%)	Nebegall, et al. (9%)
Organic - Morrison and Boyd (19%)	Linstromberg (14%)
Quantitative - Willard, et al. (15%)	Skoog and West (13%)
Qualitative - Sorum (30%)	
Chemical Engineering - Peters (30%)	

Although the predominating textbooks could be considered as belonging in the middle level of sophistication, the range was broad. For General Chemistry, the range extended from the texts for "Beginning Chemistry" by Holmes and Hein to the sophisticated, calculus-based text by Mahan. Organic Chemistry textbooks ranged from Hart and Schutz to Cram and Hammond.

With this frustrating situation existing on the educational scene and recognizing the need for increasing the size of chemical technicain graduating classes by a factor of ten, the American Chemical Society prepared a proposal to seek support for a Chemical Technician Curriculum Project. A Steering Committee was formed from the industrial, government and academic communities. A Project Director, Dr. Robert Pecsok, was recruited from the foremost ranks of chemical educators. On July 1, 1969, a grant was received for the ChemTeC Project from the National Science Foundation.

The specific purpose of the project is to prepare instructional materials for approximately 30 semester hours of work for the chemistry core of two-year post-high school chemical technology programs.

The late date of receipt of the grant delayed the first major work on the project until Summer 1970. The interim period has been spent on planning, selecting Pilot Colleges for evaluation and assembling an outstanding team of writers who will convene for an eight-week period beginning June 22, 1970. The Pilot Colleges are:

Florissant Valley Community College	Missouri	Jack Ballinger
Greenville Technical Education Center	South Carolina	Wade Ponder
Loop College	Illinois	Jack Sosinsky
Los Angeles Trade-Technical College	California	Lawrence Dalen

Mary Holmes College	Mississippi	William Royal
Merritt College	California	Peter Jurs
New York City Community College	New York	Fred Schmitz
Polk Junior College	Florida	Allen Croft
Rhode Island Community College	Rhode Island	Harry Hajian
Seattle Community College	Washington	William Wasserman
Texas State Technical Institute	Texas	Robert Krienke
Washington Technical Institute	District of Columbia	James Thomas

The Pilot Colleges are each providing a staff member to the Writing Team. In addition, the Team contains three industrial representatives and ten academic chemists. From industry we have:

Nathaniel Brenner, Ventron Corp., Cahn Division
Robert Hofstader, Esso Research and Engineering Company
William McFadden, International Flavors and Fragrances

From four-year institutions we have:

W. Robert Barnard	Ohio State University
Clark Bricker	University of Kansas
Charles Hammer	Georgetown University
Donald Hicks	Georgia State University
William Kieffer	College of Wooster
Charles Knobler	University of California, Los Angeles
Joseph Lagowski	University of Texas
Clifton Meloan	Kansas State University
Howard Purnell	University of Wales
David Shirley	University of Tennessee

ChemTeC has several goals:

1. Foremost, it wants the chemical technology graduates to be ready for immediate employment.
2. It will seek to integrate the subdisciplines of chemistry.
3. It will seek to integrate lecture and laboratory in a more intimate fashion.
4. Its materials are to be designed for the middle one-half of high school graduating classes.
5. Its materials should have a distinctively applied and "real world" flavor.
6. Its materials should have great flexibility to meet the local needs of colleges that should be meeting the needs of students and community.

It must be emphasized that ChemTeC has not been organized to dictate what must be in a chemical technology program. It is designed to be suggestive of ways in which to do a critically needed teaching job for a specific group of students.

Materials for evaluation will start becoming available in Fall 1970. Information about ChemTeC can be obtained by writing to:

Chemical Technician Curriculum Project
Lawrence Hall of Science
Berkeley, California 94720

TRANSFER CHEMISTRY PROGRAMS IN THE TWO-YEAR COLLEGES OF THE UNITED STATES

Cecil Hammonds
Penn Valley Community College

Chemistry programs for students majoring in chemistry in two-year colleges of the United States are determined by the background of the student and his community. The almost universal policy of admitting all who have attained a high school diploma presents the two-year college with students having a greater range of abilities and achievements than those who attend a large university or a four-year college. The location of the two-year college in an urban, inner city, suburban or rural area contributes to the opportunities available to students to broaden their knowledge in areas which will help them in pursuing a career in chemistry. Location and community support determine the ability of a college to provide the programs and courses that students require for a college-level equivalent transfer program which will enable them to efficiently transfer to a four-year institution to pursue their upper division studies.

Two general types of students enter the two-year college to study chemistry. These may be classified as those who are able to qualify and those who are not able to qualify for entrance into a four-year institution upon graduation from high school. Abilities and interests of both of these groups vary. Some have deficiencies in skills in chemistry, physics and mathematics required for college-level courses. Oftentimes the removal of these deficiencies enables a number of these students to eventually obtain a Bachelor's degree in chemistry. Students ranking in the upper quartile of their entering college class and most of those in the second quartile can succeed in chemistry if their background in science and mathematics is sufficient for college-level programs in these areas. The chance for success in chemistry is small for those students ranking below these levels. Motivation and maturity also influence the success of a student in the two-year college. Many students in the two-year college, especially one located in an urban or inner city area, are older than those who enter upon graduation from high school. These students show a greater degree of success for their achievement group than the younger group.

Before outlining a chemistry transfer curriculum, it is well to review the diversity of educational programs which the chemistry curriculum and courses might serve. The number of students who enroll in a general college chemistry course and later become chemists is small. Thus, most two-year college chemistry departments find it economically impractical to design individualized courses for the chemistry major. All or parts of the chemistry program may adequately satisfy the needs of students entering such fields as chemical engineering, pharmacy, medicine, medical technology, secondary science teaching as well as chemistry for the first two-years of college. In addition, courses within the chemistry curriculum service the requirements of students majoring in nursing, biology, physics, and many fields of engineering. Thus the chemistry curriculum in a two-year college becomes more economically justifiable to serve a relatively small number of chemistry majors because of the dependence of students in allied scientific fields upon chemistry as a service course.

The chemistry student successfully completing the requirements for an Associate Degree in chemistry can transfer to a four-year college or university to complete the requirements for the Bachelor's degree. His choice of institution will be influenced by many of the same factors which caused him to attend the two-year college such as finances and proximity to home and work. Some studies have shown that this student takes longer to complete a chemistry degree than his counterpart who entered the four-year institution directly upon graduation from high school. The success of two-year college chemistry students as compared with native students in four-year colleges is comparable.

In February 1970 the Committee on Professional Training of the American Chemical Society and the Two-year College Committee of the Division of Chemical Education published a set of "Guidelines for Two-Year College Chemistry Programs." This statement provides a guide to the chemistry courses which a two-year college should attempt to offer for the well prepared student and the less well prepared student who desires to obtain the first two years of a chemistry major at the two-year college. Many two-year colleges in the United States have been following programs similar to the one suggested by these committees.

The basic first year chemistry course is a one-year course in general chemistry with laboratory work. Prerequisites for this course include a year of high school chemistry and high school mathematics through second year algebra. A high school physics course is desirable. The first year college course in chemistry may consist of three lectures or classroom sessions, three hours of laboratory, and one or more hours of recitation per week. The course usually carries a credit of 8 to 10 semester units. Some colleges have four to six hours of laboratory per week. Courses consisting of six hours of laboratory may devote two hours of this time to discussion or quiz. Two-year colleges attempt to offer the basic first year course on a level commensurate with the abilities and interests of their students and attempt to bring their students to the same levels of preparation and performance at the conclusion of the course as those at neighboring four-year institutions to which their students transfer. The level and the intensity of this course depend on the students' intended goals, their previous preparation, and their need for remedial work. Typical courses follow the outlines of those of the texts of Chemistry by M. J. Sienko and R. A. Plane; General College Chemistry by C. M. Kennan and J. H. Wood; Chemistry, A Conceptual Approach by C. E. Mortimer; and Chemical Principles by W. L. Masterson and E. J. Slowinski.

Attempting to implement the "1965 Minimum Standards Used as Criteria in Evaluating Undergraduate Professional Education in Chemistry" of the American Chemical Society's Committee on Professional Training in which no more than three semesters of lecture and laboratory work are suggested for general chemistry and elementary quantitative analysis depending upon the student's high school experience, some colleges have been integrating quantitative analysis into the general college chemistry course. In two-year colleges where this has been done, the laboratory work includes work in quantitative analysis performed to a high precision. Experience in gravimetric, titrimetric, and some very basic insturmental methods is provided. Basic instrumentation used includes the pH meter, and some type of ultraviolet spectrophotometer. However, significant numbers of two-year colleges retain a one semester quantitative analysis course which includes material not included in the general college chemistry course.

The objective and use of qualitative analysis in the first year course has changed during the last decade. The set of guidelines recently published for two-year colleges suggest that the laboratory may include a limited amount of qualitative analysis as a means for teaching basic equilibrium principles and the chemistry of a limited number of elements.

The first year program in chemistry varies in level of presentation and difficulty both in lecture and laboratory. The objective, however, is to adequately prepare the student for the upper division courses that he will take at the four-year college or university which he chooses to attend.

The second year of the chemistry program for the transfer chemistry student usually will include two semesters of organic chemistry. This course includes a study of synthetic methods and some theoretical discussion of reaction mechanisms. Laboratory work in this course in many colleges involves the use of instrumental methods such as gas-liquid chromatography and infrared spectrophotometry. Typical courses are based on those outlined in texts such as Organic Chemistry by R. T. Morrison and R. N. Boyd, or Modern Organic Chemistry by J. D. Roberts and M. C. Caserio. The organic chemistry course usually involves three lecture or classroom sessions and six hours of laboratory per week and carries a credit of 10 semester units. During the second year in a two-year college, the chemistry transfer student might elect to take a quantitative analysis course if one is available.

In order to prepare the transfer chemistry student for a physical chemistry course in the junior year, the basic requirements in mathematics including calculus and a course in physics based on calculus must be completed during the student's tenure at the two-year college. Courses in English composition designed to provide proficiency in writing, courses in German or Russian which enable the acquisition of a scientific reading knowledge of one of these languages, as well as courses in the humanities and social sciences complete a typical program for this student. The planning of the transfer student's program during the first two years is partially dependent on the requirements for graduation of the four-year institution to which he plans to transfer.

Many students enter the two-year college deficient in mathematics and chemistry required for placement in the general college chemistry course. For these students who have had no previous training in chemistry or who have had a poor high school background, a one semester preparatory or remedial course is offered by many two-year colleges to prepare the students for the general college chemistry course. This course is more commonly found in the two-year college than the four-year college as a result of the "open-door" policy on admission allowing students to enter who cannot qualify for admission to the four-year institution because of their poor background. An alternative to this mechanism for the poorly prepared student is a modification of the general chemistry one year course with greater amounts of lecture, discussion, laboratory and recitation. At the conclusion of this course the student should have attained the same level of preparation as those who have completed the normal general college chemistry sequence. Most of these preparatory courses generally require a prerequisite of high school algebra. Texts used in these courses include Fundamentals of College Chemistry, by J. H. Wood, C. W. Kennan, and W. E. Bull; Introduction to General Chemistry by J. H. Holmes; Elements of Chemistry by L. P. Eblin; and Foundations of College Chemistry by M. Hein.

The "Open-door" policy of admission implies entry into the two-year college is unrestricted. It does not imply that the student should be allowed to choose a program or a course in which he clearly is incapable of reasonable success. He should not be allowed to enter these programs without proper preparation. A two-year college which is comprehensive must provide educational programs to remedy deficiencies in the backgrounds of its students. A beginning or preparatory chemistry course can provide a means to develop a student's level of training so that he can enter the first year college course with a reasonable chance of success. It is not possible to offer a first year college level chemistry course equivalent to that of neighboring four-year institutions if the needs of these less well prepared students are to be served.

Many two-year colleges have studied the performance of their students over periods of several years and have developed placement programs which are used to advise and assign entering students to chemistry courses on a level at which they will have a chance of success. These programs have shown that the performance and understanding of these students can be enhanced to the point that they are capable of completing a college level chemistry curriculum.

Among the criteria used to determine the placement of entering chemistry students are the ACS-NSTA High School Chemistry Examinations, the Toledo Chemistry Placement Examinations and the College Entrance Examination Board Examinations. Consideration of high school mathematics and chemistry grades are factors used by many colleges in determining placement. All of these examinations provide adequate instruments that help place a student at a level consistent with his achievements and abilities.

Finally, a student who enters a two-year college deficient in some skills required for the two-year college chemistry program outlined here cannot expect to finish in the time period of two years. He probably will require a longer period. However, a remedial or preparatory chemistry program coupled with a proper program of placement can considerably increase the probability of his success in chemistry.

The problems faced by a two-year college offering a chemistry transfer program fall into two general categories. These are the expense of the program and the need for articulation of the program with neighboring four-year institutions. Small enrollments in beginning chemistry courses will affect the ability of a college to offer the diversity of courses to satisfy the varied needs of its students. It may not be possible to offer a section of general college chemistry for only engineering and science majors. If this occurs, the level of training offered in the two-year program may not be comparable to that of the four-year institution. Colleges which encounter this experience will probably not have sufficient staff to offer an organic course in the second year.

If a two-year college can offer a two-year chemistry program, the major problem is one of articulation with the four-year programs in its immediate area or state. Proper coordination of programs results in the chemistry transfer student being prepared in his junior year to begin the study of physical chemistry and enables him to make a smoother transition to the four-year institution. There is also a question of course content and level of presentation. Closely related to this concern is the necessary prerequisite training required to undertake a particular course. It is generally accepted that the student should complete a full year of a general college chemistry course and a full year of the organic chemistry course at the same institution. Thus, if a two-year college offers one semester of the two semester organic chemistry course, it is desirable to offer the second semester. The transfer chemistry student will then have an opportunity to complete this second chemistry course and minimize the problem in difference in course content between the different institutions.

The role of quantitative analysis in the second year continues to present difficulties to two-year institutions.which have not completely integrated elementary quantitative analysis into the first year college chemistry course. If the equivalent of this course is not given, the transfer chemistry student may be required to take a similar course while satisfying the upper division requirements for his degree. Some two-year colleges offer one semester of quantitative analysis and the first semester of organic chemistry as the second year chemistry program.

Satisfying the language requirement of a scientific-reading knowledge in German or Russian for the ACS approved Bachelor's degree in chemistry is oftentimes impossible to schedule during the first two years of study in a two-year college as the student is attempting to satisfy the humanities and social science requirements for the Associate degree. Ideally the study of a foreign language should be accomplished in high school.

Most of these areas of concern can be minimized by cooperation between the two-year and four-year institutions within a given region or state. The student who has obtained a well-balanced program with respect to coverage in mathematics, physics, and two-years of college level chemistry including one year of organic chemistry will have few problems in pursuing and completing a Bachelor of Science degree in chemistry within two years after graduation from the two-year college.

In future years the chemistry transfer program of the United States two-year colleges will undergo many changes. One of the activities which might influence this program is the Topical Outline Project of the Curriculum Committee of the ACS Division of Chemical Education. This group hopes to bring about changes in the structure and content in each part of the chemistry program in both the two-year college and the four-year institution. The efforts of this committee could conceivably lead to a complete revision of the traditional four-year chemistry curriculum.

Working within the structure of the traditional subject areas of undergraduate chemistry, this committee of over 100 instructors from two-year and four-year institutions is developing topical outlines and statements of behavioral objectives. The General Chemistry subcommittee is writing these statements on three levels of difficulty corresponding to the degree of performance and training expected of A, B and C students.

The use of independent study methods through the use of television, films, filmstrips, tapes, programmed material, and computer assisted instruction combined with an open laboratory concept and the application of the materials developed through the Topical Outline Project should allow many students to proceed at an individualized rate. Thus the student's completion of a given course need not be restricted to a fixed period.

New approaches to course structuring between related scientific disciplines such as the integrated physics-chemistry course and the sophomore level biorganalytical chemistry course at the University of California, Los Angeles, may bring about major changes in the content and structure of the program for a chemistry major. These innovations will subsequently affect the courses offered by the two-year college.

Reform of the academic calendar to a 4-1-4 academic year introduces the miniterm concept. This short term, which might be scheduled in January, May or August, offers an opportunity to the two-year college to expand its instruction in chemistry into specialized areas. Not only can the institution make use of its resources, but it can with proper coordination make use of those in the community not readily available to its students. Reviews of specific subject areas for those whose skills are underdeveloped, instruction in specialized instrumental techniques, supplementation of the courses offered during the regular term with material directed toward specific groups of students, as well as an introduction to chemical research are some possibilities which can be incorporated into the chemistry program of a two-year college during this short intersession period.

Finally, the "Guidelines for Chemistry Programs in Two-Year Colleges" formulated by the ACS Committee on Professional Training and the Two-Year College Chemistry Conference Committee of the Division of Chemical Education establishes some objectives which every two-year college in the United States should strive to attain. This important position statement will significantly influence these chemistry transfer programs in the future.

CANADIAN "TRANSFER" CHEMISTRY PROGRAMMES

J. M. Lyons
Dawson College

One of the hardest problems faced in preparing this paper was to discover what is meant by "transfer". Most of my colleagues in Quebec had never heard of the term and those who had gave varying interpretations of the term.

It could be applied to courses organized specifically for the student who makes a drastic programme change, planned or otherwise, such as from a technical college to university (or vice versa). College preparatory programs offered in the British Columbia Junior Colleges could be considered as belonging to this class since they can be taken by a technical student transferring to a university program. There is a general feeling, however, particularly evident in the Ontario Colleges of Applied Arts and Technology, that such transfer programmes are not only unnecessary but downright undesirable since they will encourage students to leave the technology programmes and transfer to universty. As for transfer in the reverse direction, a good case can be made for the advantages of a university-trained chemist taking post-graduate training in a Technical College to perfect his practical knowledge.

The adjective 'transfer' could also be applied, in a more general sense, to programs being developed in the comprehensive colleges (particularly Quebec's CEGEPs) which are intended to facilitate programme switching, and more will be mentioned of this later.

For the purposes of this paper, I have taken 'transfer program' to mean a University equivalent or preparatory program followed, in a Junior or Community College, by students who intend, from the outset, to transfer to a university at the end of their college studies.

'Equivalent' applies to the situation in British Columbia and Alberta where some 80% of university - bound high school graduates proceed directly from high school to university whilst the remainder undertake the first one or two years of their post-secondary studies at a district or regional junior college which offers university equivalent courses. 'Preparatory', on the other hand, is applicable to the situation of Quebec where entrance to university is only open to graduates from colleges of general and vocational training (CEGEPs).

In the matter of colleges, I have confined myself to 'junior colleges', 'Community Colleges', 'Technical Colleges or Institutes' or other non-degree awarding institutions not operated for profit and not directly affiliated with universities. This corresponds to the list of Community Colleges published by the Department of Manpower and Immigration.

It is only in British Columbia, Alberta and Quebec that, within the above terms, there are colleges presently offering transfer programs in Chemistry. In other provinces transfers between Technical Colleges and Universities may take place on an individual basis though indications are that less than 5% of students in Ontario Colleges of Applied Arts and Technology transfer to universities. University - affiliated colleges may exist, such as Xavier College, Nova Scotia, which handle one or two years of the present university programme.

Three diagrams are sufficient, then, to summarize the present position as regards transfer programs in Canada. One each for British Columbia-Alberta (Fig. 1), Quebec (Fig. 2), and one for Ontario (Fig. 3) as representing the general picture in the other provinces. Though British Columbia and Quebec programs are comprehensive and offer general and vocational courses, there is a radical difference between the two provinces. In British Columbia, college attendance is optional and presently only some 20% of the university entrants have followed college courses. In Quebec, on the other hand, successful completion of a two-year college program is the necessary condition for admission to university studies. The CEGEPs are thus assured of a clientele! In Alberta it is generally only the first year of university that is taken in the junior colleges but second year courses are being developed. Another difference, as I understand it, is that the British Columbia junior colleges only offer two-year vocational programs in Chemistry and many students then go on to complete their studies at the British Columbia Institute of Technology, whereas in the Quebec CEGEPs, three year technology diploma courses are offered and there is no central Technical Institute to which students must tramsfer. In this sense then, British Columbia junior colleges can be said to offer transfer programs in Chemical Technology.

In Ontario, by contrast, the Government has made a firm decision to promote non-comprehensive Colleges of Applied Arts and Technology and it is generally accepted that there is no place for transfer programs in these: the present university facilities for science students is considered to be adequate. At Ryerson, on the other hand, which is not incorporated into the CAAT system, a large number of students are said to enter with the stated intention of later continuing their studies at university. However, I do not believe that transfer programs, as such, are offered at Ryerson.

The other provinces are at various stages of reconsidering or reformulating their college policy. Recommendations have been made in Saskatchewan that the comprehensive system be adapted. Manitoba has embarked on a system of community colleges which appear to be aimed at supplying skillful craftsmen and I do not know if there will be transfer programs in the future. In Newfoundland, a Royal Commission in 1967 recommended the establishment of two technical institutes and again, I do not know what place transfer programmes will occupy in these. New Brunswick and Nova Scotia have a history of diverse post-secondary educational opportunities, which includes transfer programs such as those offered in Xavier College. Prince Edward Island has made a start with Holland College but, it is too early to guess at the future of transfer programs in that Province.

For the remainder of this paper, therefore, I will confine myself to a brief comparison of the British Columbia and Quebec systems and to a preliminary report on the Quebec experiment with which I am more familiar.

In 1958 British Columbia introduced legislation to promote the formation of District Colleges operated by one school board and Regional Colleges operated by a consortium of boards. Seven such colleges now exist and their scope and purpose may be judged from the classes of programme offered by one--Capilano College (Table 4). In British Columbia 60% of the financing is supplied by the Provincial Government, the remaining 40% must be raised locally, including the cahrging of tuition fees. By contrast the Quebec CEGEP system is 100% government supported and tuition is free.

To better understand the organization of the Quebec CEGEPs, it is necessary to realize that, at the time of their inception, there were six parallel systems offering post-secondary education:-

Classical Colleges
Normal Schools for Teacher Training
Institutes for Home-Making Education
"Specialized Education" Institutions
Private Commercial Colleges
Universities

and that even within a single system there were wide variations in the nature of the education provided. In the words of a Department of Education publication there was: ".....an impression of incoherence and anarchy, watertight divisions between pre-university training and vocational training, a multiplicity of administrative and pedagogical systems; a repetition of numerous subjects: a variation in entrance requirements at university level between sectors and even within a single sector. All these disadvantages (resulted) from the fact that six parallel systems (occupied the field of college education. The two chief disadvantages that (resulted).....(were) confusion and inequity as far as the student (was) concerned and waste of resources as far as society (was) concerned."

Quebec, therefore embarked, three or four years ago, on a bold and sweeping reorganization of its college system in a more orderly and better integrated terms, with the expressed motive of helping the greatest possible number of students. The colleges are organized under separately constituted college boards of very democratic composition; they include professors, students, and parents as well as representatives of the local community. They are organized so as to reflect a cultural pluralism in the belief that the only way to meet the requirements of present and future world culture is to pull down all barriers between parallel systems of university and technical education. Wherever pedagogically feasible the same subjects are offered to several categories of students even though their individual programmes are directed toward different outlets--the principle of "le tronc commun". This is of practical importance also since the requirements of various career goals have common elements. Since many students may not have definite goals when they begin college, the patterns of study have been designed in such a way as to permit some students to meet the requirements of several patterns of study at the same time, especially in the first year of college life. For example, the general chemistry course taken by pre-university students is also taken by Electronic Technologists, Medical Lab Technologists, Chemical Technologists, etc.

The Department of Education is striving for a certain minimum amount of standardization in the interests of efficient operation and student mobility. All the Quebec universities have agreed to work towards this goal and a collection of general (pre-university) courses which will be offered at the CEGEPs has been agreed upon in consultation with the universities. Students who base their choice of courses on the published Department of Education recommendations are then free to apply for admission to any of the Quebec universities, French or English, safe in the knowledge that their chances of being accepted will depend mainly on their level of achievement.

In British Columbia, it appears that each junior college offers its own choice of courses designed to afford students reasonable flexibility of choice in their future studies; however, it is made clear that university admissions criteria are the prerogative of the universities and that choice of course is the responsibility of the students.

The background of students entering programs in both British Columbia and Quebec is mostly senior high school matriculation although provision is made, very explicitly in British Columbia for exceptional circumstances, such as the mature student who has not obtained a complete high school dossier, and college preparatory courses are offered in the British Columbia junior colleges.

Such preparatory programs in Quebec would be offered under the aegis of the high school boards, probably as part of a manpower re-training programme, though remedial non-credit courses are also a feature of many CEGEPs.

There are 33 CEGEPs operating, or in the process of formation, in Quebec. Two of these are English language and the remainder French, although those at Hull and the Gaspe have English sections. The programmes are identical for all. The general diploma which is required for admission to university is obtained upon successful completion of 24 one term (15 week) courses. Most students take 6 courses per term and so complete their college studies in two years. All students must take 4 English literature courses at an English CEGEP (or 4 French at a French CEGEP) and 4 Humanities or Philosophy courses and in addition, in the English establishments, must acquire a degree of competence in French if they have not already doen so.

The courses necessary for admission to university studies in the Health Sciences and Physical-Applied Sciences are shown in Table 5. Students have freedom of choice as to when, during their two years at college, they take these courses so long as the various prerequisites are met. If their time table permits, they may take additional science courses and those available in chemistry include two in Organic and two Physical Chemistry courses. Pre-university students could also take one of the Chemical Technology courses such as Qualitative or Quantitative Analysis.

As to problems associated with transfer programmes, whatever the province, it is not unusual to hear of dissatisfaction with the calibre of students entering programmes. Complaints include:-

Inappropriate choice of high school subject patterns
Poor math background
Inability to solve problems
Lack of motivation

Placement testing does not appear to be widespread in its application yet, but several colleges are experimenting with it or discussing its merits. Remedial programmes are in fairly widespread use, however.

It is too early to say what the major problems will be with the British Columbia or Quebec systems. Certainly there are numerous and time consuming problems of liaison and articulation stemming from the strategic position of the colleges between high schools and university.

The analogy may be unfortunate and not entirely appropriate. But, at Dawson, we sometimes feel like the poor man who has intervened in a fight only to find that both parties turn on him and beat him up for his interference! The analogy is indeed quite unjust for I am happy to relate that, at least at Dawson, at the end of our first year, we are still on excellent terms with our colleagues on either side of us.

The main question that must be posed in relation to the Quebec system is "Can it succeed in bringing the academic and technological worlds closer together?" Time alone will tell but the feeling in Quebec at the moment is that the ground work has been laid and that it is up to the individual CEGEPs and their members to make the experiment a success.

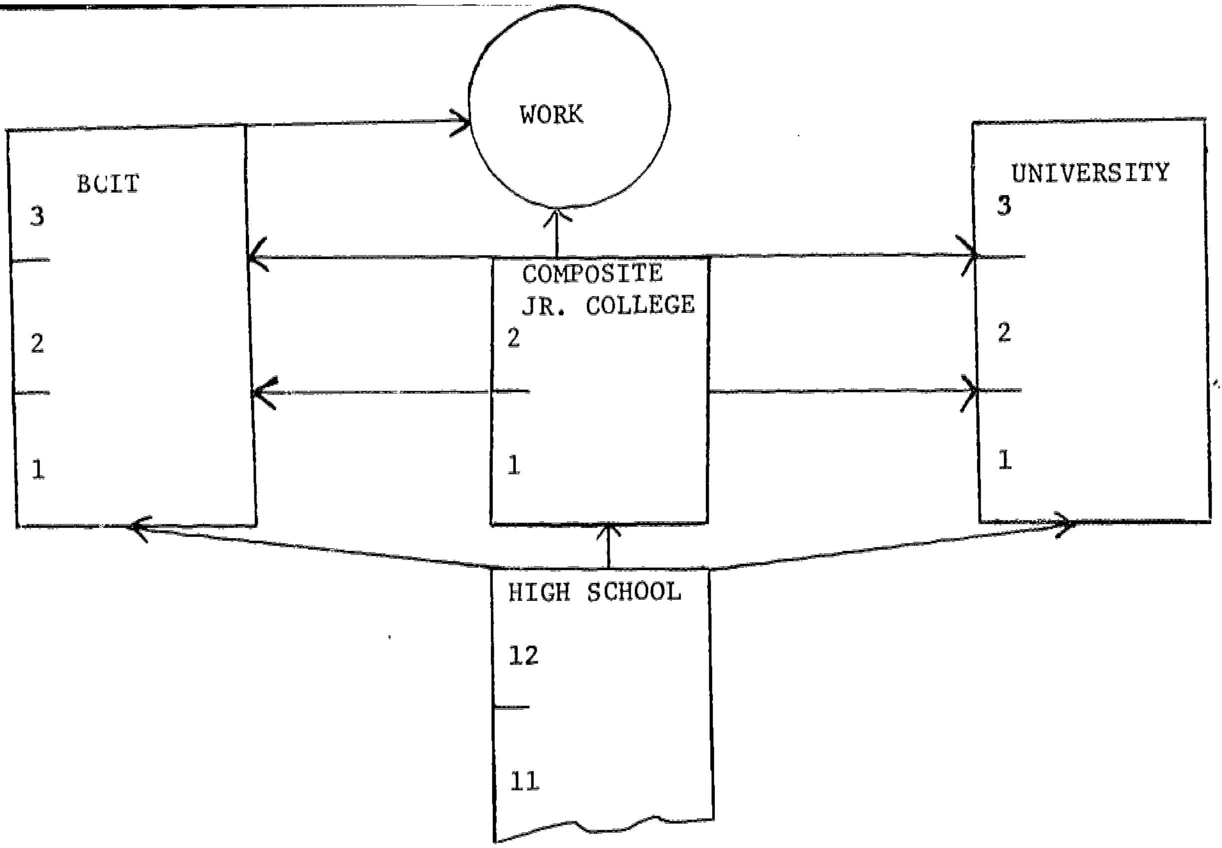

Figure 1. British Columbia

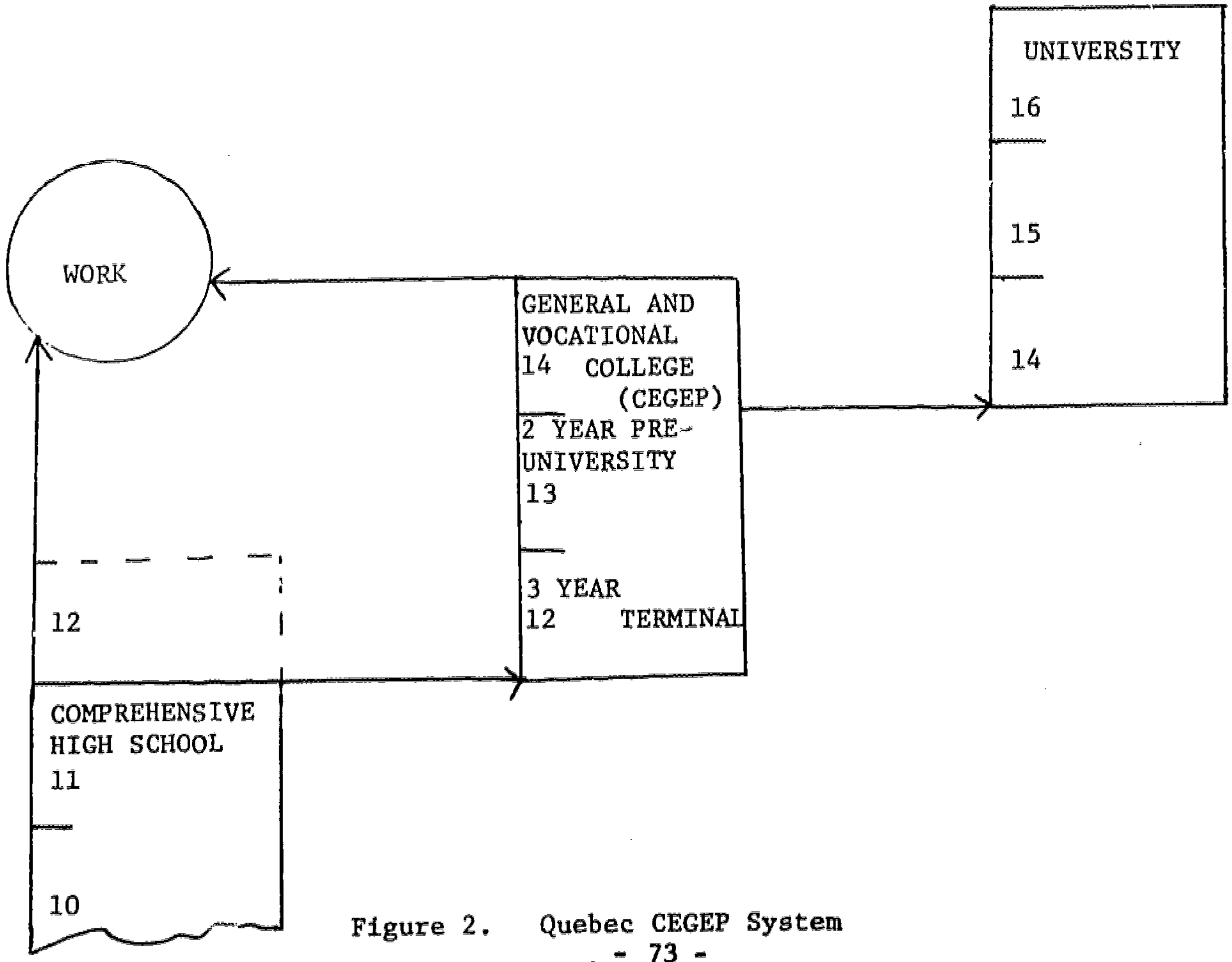

Figure 2. Quebec CEGEP System

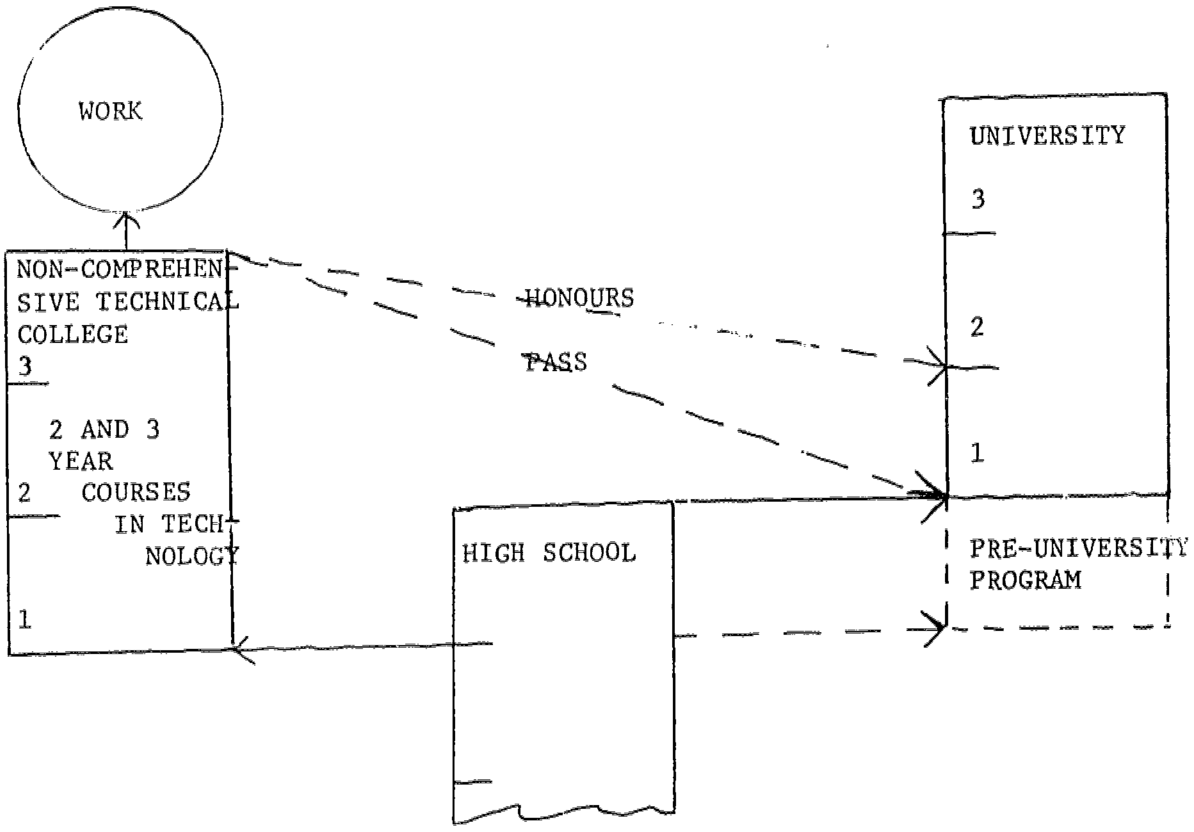

Figure 3. Ontario College System

Table 4. Capilano College Offerings

An academic transfer program in arts and sciences approved by the major universities in the province

One and two year career diploma courses leading to employment

Technological courses leading to graduation from B.C.I.T.

A general education program providing two years of academic studies leading to a college diploma

A community service program designed to meet needs of the community through short courses, seminars, and workshops

Table 5. Selkirk College Course Outlines

CHEMISTRY 112 - 3 GENERAL CHEMISTRY

The course is intended for students with a limited background in chemistry and yet who desire a course that will serve as a prerequisite for any subsequent course in chemistry. It is identical to chemistry 122 in content but requires one additional hour per week

CHEMISTRY 122 - 3 GENERAL CHEMISTRY

Chemical thermodynamics, gases and the GSA laws electronic structure of the atom and elementary quantum [illegible]. Chemical bonding, solids liquids and changes of state. chemical equilibrium chemical reactions, (3,3) (3,3)

CHEMISTRY 212-3 ORGANIC CHEMISTRY

Structures and reactions of aliphatic aromatic qand heterocyclic compounds, introduction to natural product chemistry
The laboratory portion of the course introduces students to modern instrumental techniques such as infra-red spectroscopy and gas-liquid chromatography (4,3) (4,3)

CHEMISTRY 220 CHEMICAL BONDING - ANALYTICAL CHEMISTRY

Quantum chemistry, spectroscopy and molecular orbital theory, the separate laboratory introduces inorganic synthesis and instrumental analysis colorimetry, infra-red spectroscopy, gas chromatography and polarography (# 3,4) (0,0)

CHEMISTRY 222 PHYSICAL CHEMISTRY

An integrated lecture laboratory course dealing with physical chemistry, thermodynamics equilibrium, kinetics and electrochemistry (0,0) (3,3)

APPENDIX B

RECOMMENDATIONS FROM CONFERENCE ON SCIENCE IN THE TWO-YEAR COLLEGE

The following recommendations were developed by representatives of 17 national scientific and educational organizations during a "Conference on Science in the Two-Year College" held in Washington, D. C., June 18-19, 1969. The conference was supported by the National Science Foundation and sponsored by the Commission on Undergraduate Education in the Biological Sciences (CUEBS). A list of conferees is available. These recommendations were transmitted to the conferees for presentation to the group they represented with a view toward support and implementation of the proposals.

I. CURRICULUM

IT IS RECOMMENDED THAT IN THE MATTER OF:

1. Curriculum Development
   - a. Science faculty members at two-year colleges play the dominant role in designing science courses and in making decisions concerning the science component of any curriculum offered on their own campuses.
   - b. Those concerned with the science content of two-year college curricula recognize that curricular decisions can be aided by objective study and analysis and need not be based entirely on personal prejudice.
   - c. Two-year college faculties respond to the diverse needs of their students by offering an appropriate variety of programs in the sciences. Some of these should prepare students for upper division programs at four-year colleges and universities and some of these should prepare students for specific occupations.

2. Occupational Curricula
   - a. The science content of occupational programs be the joint concern of faculty in science and faculty in the occupational programs.
   - b. Those concerned with the science content of occupational programs at two-year colleges seek advice from outside specialists who are familiar with both technician employment and two-year college occupational programs.
   - c. The various segments of curricula for the training of technicians be carefully coordinated so that concepts and skills learned in one course will be used to maximum effect in another, and that this coordination be the joint responsibility of faculty members in science and mathematics and in the technology subjects.

3. Transfer Curricula and Articulation
   - a. Two-year colleges, through the science faculty, be encouraged to establish articulation arrangements with four-year colleges and universities, through their science faculties, in order to facilitate the transfer of students. The two-year college science faculty should also be encouraged to utilize innovative approaches to curriculum construction and methodology and to preserve the autonomy of their institutions.
   - b. Two-year college science faculties be encouraged to experiment with innovative transfer programs and not feel obligated to imitate the lower division offerings of any one four-year college or university.
   - c. Four-year colleges and universities (including their science faculties) admit promising students from two-year colleges even in cases where their curricular

programs deviated significantly from conventional transfer programs.

d. Four-year colleges and universities offer programs which enable suitably qualified students to transfer smoothly from programs offered at two-year colleges to their own upper division programs.

4. Advising

a. Advisors of two-year college students encourage potential transfer students to complete course sequences in subjects related to their field of major interest before transfer in order to increase the probability of success after transfer.

b. The science faculty is encouraged to develop a closer working relationship with students and a better understanding of academic, career, and personal problems to the end of insuring that students set realistic goals for themselves and receive proper placement in their first courses in science.

c. Two-year college guidance and counselling personnel are encouraged to work closely with the science faculty to assure proper placement as well as goal-orientation of the student.

5. Certification, Accreditation and Standards

a. The proper concern of state and national agencies for certification and licensing of graduates is the competence of individuals and not specific curricular standards and guidelines.

b. Accreditation of two-year colleges is the proper concern of certain regional accrediting agencies, but the approval of curricular programs is primarily the concern of the faculty and administration of the institution offering the program.

6. Teacher Preparation

a. Each university science department accept the responsibility for the preparation of two-year as well as four-year college teachers of its discipline.

b. There be given the broadest possible encouragement for the development of innovative experimental programs leading to better trained teachers (hence, better teaching for the two-year colleges and others) and for the careful study and evaluation of the results of those programs.

c. The minimum academic preparation for a two-year college science teacher be equivalent in level to a master's degree <u>in the discipline</u> to qualify in the the subject he teaches and that further academic training is highly desirable and should include, but need not particularly stress, science research. However, it is recognized that each two-year college should have the right to set all standards for faculty appointments.

d. Appropriate preparation for the two-year college science teacher should include supervised teaching experiences, supervised by a science department, (preferably in the two-year college) that provide knowledge of the kinds of students and the nature of the institutions in which he might teach as well as knowledge of materials and methods for teaching his discipline.

e. Science teachers for technician preparation programs be familiar with the applications of their disciplines to the relevant technologies.

II. PERSONNEL

I .S RECOMMENDED THAT IN THE MATTER OF:

1. Teaching Loads

a. Professional societies and the science commissions recommend appropriate teaching loads for the two-year college faculty in their field, taking into consideration the following factors: contact hours rather than credit hours; number of preparations and new assignments; number of students (student contact hours); availabilities of technical, secretarial, and instructional assistance; time spent on the development of curriculum and course materials; non-traditional patterns of scheduling; time spent in counselling and guidance work with students; non-teaching assignments (faculty and administrative committees, club sponsors, etc.).

b. Regional accrediting associations should review and evaluate faculty teaching loads in member two-year colleges in the light of the recommendations made by professional societies and college commissions.

c. Faculty should use the time made available from load adjustments to improve, to evaluate, and to keep current their teaching, instructional materials, and competence in their field, and to increase student-faculty interaction.

2. Technical Assistance

a. Science faculty should be provided with technical assistants to assist with laboratory and lecture equipment, supplies, and materials (e.g., technical assistance capable of preparation, distribution, storage, maintenance, repair care, ordering, inventory, budget preparation, calibration, cleaning, and construction).

3. Secretarial Assistance

a. Science faculty should be provided with secretarial help competent in science and mathematics and conveniently available to the faculty to assist with correspondence and in the preparation of course materials and examinations.

4. Professional Affiliation

a. Science faculty belong to their respective professional organization(s) and participate in their activities; conditions of their appointment should make it possible for and encourage that they do so (e. g., released time, paid substitution, travel support, etc.).

b. Professional organizations should accommodate the special problems and interests of the two-year college science teacher to enable them to meet their obligations both to their profession and to their students.

5. Sabbatical Leaves

a. Program of sabbatical leaves be developed and instituted by all two-year ins tutions of higher learning; the released time is to be utilized by the facult member in attaining additional educational and professional goals.

6. Research

a. Research in the scientific discipline be encouraged and research efforts directed toward improving education in the discipline be promoted.

b. Scientists in two-year colleges must take the initiative in developing productive research programs and aggressively seek support for these programs

c. Foundations and other granting agencies should continue to expand their efforts to provide science instructors in two-year colleges with financial support for their research efforts.

d. The professional scientific organizations recognize two-year college science faculties and provide an outlet for their research concerns and efforts, both scientific and educational.

7. Faculty Improvement Programs
   a. Two-year colleges should develop local or regional in-service educational programs for their science faculty, the programs designed to increase competence in their own and closely related fields and the ability to communicate an understanding of their field to students. (Among the activities suggested are: faculty seminars, visiting scientists from neighboring colleges and industries, field trips to neighboring colleges and industries, small group study sessions, and the accumulation of library resources for the faculty.)
   b. Foundations, agencies, and graduate schools administering special programs for two-year college faculty should recognize that a large percentage of these teachers are involved almost exclusively with introductory or general courses and that they will gain significantly from programs and material that will bring out the relevance of the subject matter to their teaching and also improve their ability to present that knowledge to students utilizing modern teaching methods and resources.
   c. Related industries and two-year colleges or systems should develop and support internships or special traineeship programs for science faculty from cooperating colleges which do not have appropriate industrial experience but teach supporting science courses in occupationally-oriented curricula.

8. Faculty Governance
   a. Faculty, among others, should have a voice in such personnel policy matters as those relating to academic rank, salary, promotion, hiring, and dismissal.

The following table indicates the distribution of responses to the recommendations by members of the Two-Year College Chemistry Conference Planning Committee.

Rec. No.	(S) Support	(D) Dis-agree	(N) No Position
(I) 1a	32	1	0
b	31	0	2
c	32	1	0
2a	29	1	3
b	29	0	4
c	30	0	3
3a	33	0	0
b	31	0	2
c	28	2	2
d	33	0	0
4a	32	0	1
b	31	0	2
c	32	0	1
5a	26	2	5
b	30	0	3
6a	24	2	7
b	26	0	7
c	25	3	5
d	24	3	5
e	28	0	5

Rec. No.	(S)	(D)	(N)
(II) 1a	29	4	0
b	27	5	1
c	33	0	0
2a	33	0	0
3a	31	0	2
4a	32	0	1
b	31	0	2
5a	32	0	1
6a	27	1	5
b	21	4	8
c	24	3	6
	29	0	4
7a	31	0	2
b	32	0	1
c	29	1	3
8a	30	1	2
(III) 1a	33	0	0
b	30	0	3
c	28	1	4
2	32	0	1
3	33	0	0

APPENDIX C

Teacher Development Needs as Expressed by Two-Year College Teachers

(In 1967, the Advisory Council on College Chemistry conducted a survey of two-year college chemistry teachers. The following recommendations resulted from suggestions made by the two-year college chemistry teachers to open-ended questions.)

SHORT COURSES

> Short courses to keep the faculty current with respect to new developments in chemical theory and practice are proposed. The courses should be intensive in nature and deal with specific specialized topics.

Two-year college chemistry faculty members expressed a need for the establishment of a continuing program for up-dating their chemical knowledge. Many desire to increase their background knowledge on topics now included in general chemistry. Others suggested this is the best way to stimulate them, to sustain their interest in chemistry and its teaching, and to satisfy their scientific intellectual needs. Many instructors indicated that when they become up-dated they can up-date their course material.

An expressed obstacle to keeping up-to-date is that faculty forget material which they do not have occasion to make significant use of in their teaching. Many instructors indicated they do not have the time, the resources, or the ambition to dig necessary information out for themselves but would participate and profit from short courses such as those described herein.

Several formats are possible for a short course program. The two most feasible are represented by the four to ten week National Science Foundation Summer Institutes and the one-to-three-day American Chemical Society Short Courses. Both of these programs received many favorable comments from the responding two-year college faculty. Other suggested formats include a weekly, biweekly or monthly seminar series with discussion; a one to three weeks intensive special topics or refresher course; and a lecture series. The most frequently mentioned formats were one-day sessions on Saturdays throughout the academic year; one-week programs offered at convenient vacation periods during the academic year or at the beginning or ending of the summer; and six-weeks programs during the summer. Short course offerings should be available annually or bi-annually in a given geographical area.

Many respondents suggested that any type of a short course program should be run in conjunction with a seminar on the teaching of general, organic or analytical chemistry, such as those described in the next sections of this report.

Self-study guides or resource packets should be prepared on the special topics covered in short courses and the teaching of these topics in college chemistry. These would be used by faculty members who are unable to participate or who prefer independent self-study programs for up-dating their knowledge. The Advisory Council on College Chemistry Resource Papers and the American Association of Physics Teachers Resource Papers have been valuable enough to support this idea. Each short course should have as an end result an instructional package including the materials assigned; audio-tapes and scripts of the lectures given; copies of the audio visual materials utilized if feasible; and a bibliography on the topic(s) discussed. This package would present the essence of the short course and should be made available to interested faculty.

Short courses should be offered in various geographical regions of the country and within commuting distance of large concentrations of two-year college faculty. The same short course could be given in different centers with a minimum of duplication of effort.

Intensive type courses for short periods of time at a moderate level of sophistication and of recognizeable value to the teacher are desired. Course topics should be selected by the area teachers or a representative group of them. The courses must be well taught by university professors who are experts in the field of the topic or by persons actively involved in research. There was more interest in having the courses explain topics rather than in having the topic derived.

Several other suggestions were made which might be of interest to those designing short courses. One day sessions should start from scratch and move rapidly and logically as far as possible using modern methods of presentation. Short courses should allow attendees to observe a good lecturer in action, to pick up a few ideas on presentation, to gain modern ideas and viewpoints, and to progress beyond the teacher's present knowledge. The courses should teach concepts and not facts and should stress new discoveries, techniques and theories.

The short, critical survey type courses should not look at only one man's work and opinions but look at the spectrum of work and opinions found in the literature with respect to the topic.

Students could be required to do a certain amount of independent study and to present a seminar or a paper on the topic or some aspect of it before the group. Such a paper should require use of the chemical literature.

Several dimensions of accessibility of short courses to the two-year college faculty were of concern to the respondents. Financial accessibility requires that a portion of the cost must be borne by the college or some other agency in order for the faculty to participate. Time accessibility requires that load considerations may have to be made by the colleges if faculty are to have the time to participate in a meaningful way. Geographical accessibility requires that the topics be covered in a general manner so that those with little exposure to the topic would not feel they were unable to follow the presentation.

A Short Course Series might be developed under a general theme such as "Recent Advances in Chemistry" or several such series could be developed such as "Recent Developments in Organic Chemistry", "Recent Developments in Physical Chemistry", etc. Summers appear to be preferred for courses of this type.

Topics suggested for special topics short courses are acids and bases, molecular orbital theory, coordination chemistry, chemical kinetics, chemical equilibrium, phases and phase changes, quantum mechanics in structure, thermodynamics, symmetry in chemistry, bonding and molecular structure, forensic chemistry, photo-chemistry, chemistry of the rare gasses, ligand field theory, nomenclature, and specific analytical techniques.

Interdisciplinary topics suggested include medical applications of chemical principles, biochemical applications of chemical principles, modern physics and electronics for chemists, chemical principles in industrial chemistry, specific chemistry of industrial products and processes, new mathematical concepts applied to chemistry, applications of atomic energy to peaceful purposes, applications of chemistry in other fields.

CHEMICAL EDUCATION SEMINARS AND COURSES

Chemical education seminars and courses are proposed. These should be concerned with the teaching of college chemistry and emphasize problems commonly encountered in chemistry teaching in the comprehensive community colleges.

The two-year college chemistry teachers expressed a strong desire to improve their teaching effectiveness by improving their methods of communication with students and by learning how to present their subject matter more effectively. Teachers have experienced the subjects they are teaching from a student's point of view in their own undergraduate and graduate studies. Advanced course work in chemistry gives them more of the student view of chemistry. Some respondents feel the need to experience chemistry from a teacher's point of view in order to defend, with complete understanding, topics presented and methods and materials used.

Many two-year college chemistry faculty have a unique need for and a genuine interest in meeting with their counterparts from other institutions to discuss mutual proglems, to plan course improvements, to consider teaching materials and aids, to exchange ideas concerning the teaching of chemistry, and to consider successful methods of teaching chemistry in comprehensive, community college situations. Chemical education seminars would help these busy teachers keep up with new developments in chemical education. The seminars have a unique potential if properly designed, to develop professional chemical educators for community colleges so the college does not have to rely on chemists poorly trained to teach or teachers poorly trained in chemistry.

The seminar format should provide the faculty member with the thinking of many people on a given topic, something generally not available in his small college, and thereby allow him an opportunity to develop a more authoritative solution to teaching problems. Instructors could also prepare materials and make presentations relevant to their teaching assignments and have these critiqued by their colleagues.

These seminars would provide university chemists with a greater insight into the two-year college chemistry teaching personnel, their programs and their problems.

Several possible formats were suggested for chemical education seminars. Discussion seminars are favored with the participating teachers having a common bond of teaching the same course. Participants could take turns presenting interesting topics related to a central theme and then these topics would be discussed by the participants.

Another format suggested by several persons is for a seminar to be taught, that is organized and guided, by an expert in the teaching of college chemistry, a proven master teacher who has an interest in chemical education. He could also invite appropriate resource persons in for specific topics.

The most rewarding format would probably be a synthesis of the two described above. The seminar would be the responsibility of the master teacher who would organize and present the major part of the formal presentations for the course. Each formal presentation would be followed by a discussion of the presentation and of the experiences of the participants related to the topic. Selected participants would prepare short presentations related to the topic or present critiques of the master teacher's presentation. Outside resource persons would be used, when appropriate, for formal presentations or critiques, individually or as a part of a panel. Discussion periods could be followed by workshop sessions during which participants would prepare materials for demonstration, experiment, or presentation realted to the topic.

Another interesting seminar format suggested was one which would involve visitations: to the two-year colleges, four-year colleges, and high schools in a given area.

To maximize the value of such seminars to two-year college chemistry teachers a two-pronged program of seminar related publications is suggested. A first type involves a collection of short papers devoted to "How Do You Teach A Certain Specific Topic". These would be prepared by several seminar participants and describe how they teach a certain topic in general chemistry. These papers should include an outline showing lecture topics, utilization of audio-visual aids, relevant lecture and laboratory experiments and how they are related to the lecture topic, comments concerning relevant recent advances in chemistry and examples and information on how the student is tested on the topic.

The second type of publication is a curriculum guide for a given course. It should be more general than the first type and reflect current thinking on course content and teaching methods. It should include the objectives of the course stated in learning or student behavioral terms, a statement of desirable prerequisites for the course and guides on building the instructional program on these requirements, course content, a list of instructional aids, with comments on their applications, and a discussion of methods of evaluating students and the course.

The comments of the respondents strongly suggest that for such seminars to be effective the participants should have a thorough knowledge of the various widely used methods of teaching college chemistry. This need suggests that chemical education courses are also necessary. The first course in such a series should consider the basic ideas and techniques involved in presenting chemistry lectures, demonstrations, laboratories, and examinations. It should consider teaching aids and other instructional materials. The application of recent research on college student learning in the sciences should be included.

This basic course could easily be followed by a second course devoted to recent developments in the teaching of college chemistry. This would consider various innovations and new techniques in teaching chemistry; new methods, materials and equipment; and instructional programming.

A third course and, perhaps, here more of a seminar approach should be introduced, would be devoted to the teaching of chemistry in the comprehensive, community college. This course would specifically consider problems unique to the teaching of chemistry in the two-year colleges. The application of the new teaching aids and methods to the problems of teaching general chemistry, and other courses, to typical two-year college students would be studied. The emphasis would be on developing ways of reaching these students by presenting material at their level considering their background. Much attention would be given to motivation techniques and improving methods of communicating with such students. Consideration would be given to teaching general chemistry to the extremely heterogeneous student body usually found in the smaller colleges.

A fourth course or seminar in the series would, in reality, be a series given over a period of several semesters or summers. It would be entitled, "The How To Teach [illegible]" seminars. Each semester a particular topic found in general chemistry, or other course taught in the community colleges would be selected. As example might be "The Teaching of Thermodynamics in General Chemistry". This seminar would consider how you teach thermodynamics to develop student understanding of the ideas themselves; how you present the major concepts of thermodynamics; how you test on the subject; what laboratory and lecture experiments would be useful in teaching thermodynamics in general chemistry;

and what you should expect of the student? The aim of these seminars would be to help teachers adapt new techniques and information into their courses. An evaluation of different techniques and their effectiveness in teaching a given topic should be made in such a program. It is imperative that these seminars consider different approaches to the teaching of a topic, such as thermodynamics, rather than attempting to give a single approach. What has been done successfully and unsuccessfully in the field should be considered.

The "How To Teach It" seminars should consider the "tougher" general chemistry topics. They should fill in the teacher's knowledge gaps and give him the tricks of getting the topic across plus offering him a clear idea of how "deep" they should go into the topic. The seminar should help the teacher enrich his course and give him several steps of sophistication beyond his students. It should deal with teaching conceptually as well as factually these topics in chemistry presented at the community college level. It should illustrate various theoretical points by lecture demonstration experiments, gimmicks and visual aids. It should consider new and significant course content; how to integrate the knowledge; and how to apply the latest related developments in chemistry to these courses.

A fifth seminar in the program should be devoted to new developments in curriculum, textual materials, teaching aids, equipment, laboratory programs, etc. This seminar should apprise participants of new developments, give them an opportunity to make case studies, and either evaluate the developments, give them an opportunity to make case studies, and either evaluate the developments or have them evaluated. Developments should be considered at the high school level, the community college level and the university level. The implications of any developments considered to the teaching of chemistry in the two-year colleges should be included.

A sixth seminar should be more concerned with what to teach in specific two-year college courses and how to teach it. This would also include objectives, prerequisites, content, teaching aids, evaluation, specific experiments, demonstrations, and methods of presentation. It should identify both the fundamentals and the sophistications of the course.

Persons interested in chemistry for non-science majors wanted to know not only how to teach the course but to have textual materials, teaching aids and laboratory programs reviewed for them. They wanted to know how to go about relating chemistry to these students. Persons teaching chemistry courses having a large number of non-chemistry majors were concerned about the chemistry needs of the allied sciences and other professions. They wished to know more about the applications of chemistry in these areas and also how they might devise suitable laboratory experiments for such students. A seventh seminar should be devoted to the preparation of questions suitable for quizzes and examinations in chemistry, the construction of tests, and the evaluation of tests.

An eighth seminar devoted to lecture or demonstration experiments in chemistry would be popular. It should consider ideas for demonstration and provide information and experience in presenting demonstrations in ways in which they can realize their maximum learning potential.

The expressed concern for effective and efficient laboratory teaching indicates that a ninth seminar should be devoted to the topic of modern laboratory teaching trends. Among the topics to be considered would be the objectives of laboratory work, the values of laboratory work, the organization of the laboratory program, efficiency in the laboratory experiments, and the correlation of laboratory programs with lecture programs.

A tenth seminar entitled, "Chemistry in the Two-Year College" was strongly argued for by respondents. It should consider the chemistry curriculum of various two-year colleges including the chemistry courses taught in these colleges and their content as well as the objectives of the curriculum and courses. This seminar might consist of a set of case studies. It should also include budgeting for chemistry programs, faculty loads, and the organization and operation of chemistry departments including the chemistry courses taught in these colleges and their content as well as the objectives of the curriculum and courses. This seminar might consist of a set of case studies. It should also include budgeting for chemistry programs, faculty loads, and the organization and operation of chemistry departments including stock-room, inventory, technicians, etc.

An eleventh seminar should consider "Chemistry in Industry and Its Application to College Teaching". Faculty members are concerned about the industrial uses of pure chemistry, the application of the ideas and theories which they are teaching in industrial situations, the trend which chemistry is taking in the business and industrial world, and how they can train their graduates so they can get jobs in industrial situations.

There is a concern for safety in the chemistry laboratory. This could be included in a laboratory seminar or might be the basis for a separate seminar.

Chemical education seminars should be offered both in the summers and during the academic years, preferably on Saturdays. Summer programs could be intense two to five day sessions, especially for the specific topics, intensive two weeks courses, or more comprehensive three to six weeks programs. These courses should probably be on a three or five year repeating cycle.

The preference of the respondents was for courses to be available at universities in metropolitan centers within commuting distance of a large number of two-year college faculty. Some suggested these be held on two-year college campuses instead of four-year campuses. Academic-year programs might be held within the departments of large community colleges.

Graduate credit and financial assistance should be provided by the college or some other agency so more faculty can participate. Colleges should make load reduction considerations to enable faculty members to effectively participate in such programs during the academic year and to work the results of their participation into their instructional programs.

Chemical education seminars must be of recognizable value to two-year college faculty; must provide an opportunity for feedback from the faculty to the persons responsible for organizing the course; and must emphasize areas of concern to the faculty. An advisory committee should be set up for such a chemical education course and seminar program. This committee should include one representative from each two-year college chemistry department to be served by the program if it is an area or a regional program. If it covers a broader area then representative faculty members should be invited. Some two-year college deans of instruction, presidents and science division chairmen could be included.

The seminars should be continuously available but in a continual state of flux to keep in step with new developments. The sponsoring institution should designate the difference in content from term to term by specific titles rather than by generalized titles so that credit can be granted by the two-year college for salary advancement.

Such courses should not be under the auspices of education departments or education department personnel because faculty feel the traditional education department approaches are a waste of time, not advanced enough and handled by personnel not experienced at teaching chemistry in the community colleges.

IMITATIVE INSTITUTES

> Programs are proposed which have the two-fold purpose of showing ways of effectively presenting various chemical topics and of providing opportunities for discussion of the subject matter presented and why it was presented as it was. These programs should give the teacher experience in their subject from both a teacher's point of view and a student's point of view simultaneously. Faculty members should become better acquainted with the material under study while they are also able to critically evaluate various teaching techniques, demonstrations, experiments, teaching aids, tests or examinations, and other teaching materials. The result of these programs should be more effective course organization by the teachers and presentations of concepts in ways which will improve student understanding and learning.

Many two-year college chemistry teachers expressed an interest in seeing master teachers in action. Some desire to see several persons present the same topic while others desire to follow one man through a course. They also desire to have an opportunity to discuss with the master teacher "what" and "why" a topic was included or treated as it was. These respondents expressed the belief that the learning potential of lecture or demonstration experiments and other teaching materials is better understood when seen in a real life teaching situation. Many teachers indicated a desire to get themselves actively involved, as a student, with the newer or more complicated topics in their course.

A program which would allow teachers to fill in their own knowledge "gaps" and at the same time learn some of the "tricks" of getting the topic across to students in an understandable form would appear to have merit. This combination should provide a teacher with a clearer understanding of the reasonable breadth and depth for topics in their course.

Three formats have been suggested for achieving these goals. The first, the "imitative institute," has been described vividly by Professor Peter Yankwich, University of Illinois, as a translation of one of the most ancient of teaching devices -- the apprenticeship. It brings its participants into the fullest possible contact and confrontation with a course of study which is very much like the course they will be expected to teach in their college. Participants attend all the regular lectures of the institute observation course at the university, e.g. the regular general chemistry course. They perform all the work normally required of the college students in the course, except that the laboratory work may be abbreviated. In addition each lecture, laboratory, and quiz section is followed, and/or preceded, if expedient, by a special session limited in attendance to the imitative institute participants and the teaching staff. During these smaller sessions the current work in the course is discussed and dissected in detail.

Concepts of content and of methodology are assumed appropriate in the imitative institute. The desired result is that each institute participant, upon successful completion, will be qualified to teach in his own institution the content of the course by "imitation" of his own intensive experience. The professor teaching the imitative institute course should use more than just the lecture method. When it is to the best interest of the understanding and transmitting of material to use new and experimental educational aids they should be used. This experience should provide the teacher with a complete, tested, effective package of topical coverage and related learning work through his participation in a specific course like the one he will be called upon to teach. The special sessions should afford him the opportunity to ask and have answered the questions he has himself and the kinds of questions he anticipates his students will ask him. The understanding he achieves at that time should be particularly germane to his own instructional requirements. During the institute he should be strongly focused by teacher-generated pragmatic considerations.

The principal advantages of the imitative institute approach are that the teacher is not required to make his major efforts the prosecution of tasks likely to be especially difficult and time consuming for him; that is outlining, reduction, and resynthesis of material learned at one level for instruction at another level. For the teacher repetition of his cycle of instruction should be just as productive of additional insight and deeper understanding as it always has been.

Two groups of people should benefit most from this kind of approach: the seasoned instructor, who has not had the chance to up-date his material for a number of years, especially, in general chemistry, though his gain is by no means limited to this kind of material, and persons intending to enter teaching for the first time after initiating or even completing a career in other chemical areas.

The imitative institute professor, a seasoned lecturer and master teacher, will also have a chance for a critical evaluation of his own course, in terms of both content and methodology.

The second format for a program of this type is topically oriented rather than course oriented. It is designed to show the presentation of current topics in general chemistry, or any other course, by having authoritative and masterful teachers present lectures which they feel are effective in getting across difficult concepts. These presentations should be followed and/or preceded by a discussion and dissection of the presentation as described above. Whereas the imitative institute would have to be restricted to a summer program or for instructors on leave, this proposal is for a series of such presentations by different persons, not as a part of a regular course but as simulated presentations from the courses of the master teachers. These programs could be offered on weekends or in short intensive one to three week periods.

The third program format involves a visitation program through which the two-year college chemistry faculty would observe several outstanding teachers of the course they are teaching from one to three week periods and analyze the presentations with the master teacher. This would require the faculty members to travel extensively during a given term and would allow them to see several different teachers in action and get many different ideas. It would not have the continuity of the imitative institute program.

All three programs should provide ways for allowing instructors to discover ways of more effectively presenting their material and for developing, selecting and utilizing new teaching materials. They give the faculty member an opportunity to become involved with presentations of the subject matter at the level of the student.

TEACHING AIDS CENTER

> A college chemistry teaching aids center is proposed to develop teaching aids, to study the application of available teaching aids to college chemistry teaching problems, to organize and present courses which would instruct college chemistry teachers in the utilization of various teaching aids, to collect all available commercial teaching aids and materials suitable for college chemistry, to provide participating faculty with an opportunity to review and make teaching aids, to conduct research on the effective utilization of such aids, and to publish information of value to instructors concerning such aids.

The diversified curriculum and the heterogeneous student body of most community colleges requires the effective use of all types of teaching methods and aids in the instructional program. To use such methods and materials effectively the faculty must be familiar with the methods, know what materials are available, be proficient in the use of both, have an opportunity to develop new teaching aids and be able to evaluate both aids and methods in actual instructional situations.

The limited funds available to most two-year college chemistry departments argues strongly for providing their faculty with opportunities to become thoroughly acquainted with newer teaching methods and aids through a process of review and discussion before they are required to lay out college funds for purchases of new equipment and materials. Many new techniques are available to improve the level of student learning and many new materials are available to bring to the students equipment and experiments which it is impossible for them to obtain at their college.

The activities proposed for the college chemistry teaching aids center fall into five general categories: (1) presentation of courses and seminars for chemistry teachers; (2) development and application of new teaching aids and materials; (3) collection of teaching aids and equipment for the use and review of participating faculty; (4) study of the most effective devices to aid in student understanding in given situations; and (5) the publication of information concerning the availability, evaluation, and application of various aids, materials and equipment.

Several approaches for chemistry teaching aid courses are possible. The most frequently called for would give instruction in the various methods of teaching chemistry utilizing available teaching aids. Participants would be given an opportunity to utilize and make visual aids and other materials and they would be instructed in such use.

Another approach to such a course could present various audio-visual materials and demonstration equipment in a formal fashion followed by a critical evaluation by a competent panel of chemistry teachers. The materials would be presented and discussed in terms of their contribution to the learning and teaching of various chemical concepts in specific courses in the community colleges. Many faculty members expressed the need for information on visual aids and gimmicks which are relatively inexpensive and which could be used in colleges with limited financial resources.

Many respondents expressed an interest in a course that would consider techniques of improving the level of student learning through the use of teaching aids and materials. This group was particularly interested in the effective use of the newer developments in teaching methods and aids such as multi-media programmed instruction.

There is also interest in courses devoted to individual techniques such as instructional television, computers, audio-tutorial systems of instruction, programmed instruction, etc.

There were many requests for a less formal workshop program where participants would exchange ideas on various visual aids and demonstrations and work together in applying them to their present course situation as well as to develop new materials.

The demand for the preparation of imaginative, relatively inexpensive, easy to use teaching aids is great. Among the materials and methods suggested for development are: 8mm film loops, movies, transparencies for overhead projection, film strips, models of all types, programmed instructional materials, TOPS overhead demonstration materials, lecture demonstration materials, slide sets, television tapes and audio response device materials. Movies which would compensate for the lack of expensive equipment and still give two-year college students the necessary background and familiarity with chemical techniques and applications are especially desired. Fifteen minute lectures by renowned chemists on television tape and multi-media instructional system packages for use in audio-tutorial courses typical of community colleges are desired.

The center would develop a collection of all commercially available teaching aids and equipment suitable for use in college chemistry These should be readily available throughout the year and in the summers for faculty to use at their convenience, so they can review and evaluate them before they have to lay out limited budgetary funds for their purchase.

Shop facilities and media production facilities should also be available for faculty members to develop new materials which can be tried and evaluated either in the center or at their college.

The teaching aids center should conduct research projects, designed to study and develop new teaching methods and apply them in the two-year college teaching situation. They should study the most effective devices and materials to be used to aid in student understanding in various topics and teaching situations. They should conduct research on planning of lecture, laboratory, learning center, and laboratory facilities for the effective use of teaching aids in the chemistry instructional program.

The center should publish lists of all known visual aids available for college chemistry teaching and make suitable recommendations for their use with given topics and in given instructional situations. The center should report on its evaluation of available teaching aids and materials. It should report on the innovative uses of teaching aids in college chemistry and on the research projects mentioned above.

In establishing such a center, accessability to the two-year college faculty must be a prime consideration. Because of the heavy teaching schedules of the faculty members the center must be accessible throughout the academic year, not only throughout the daytime but in the evenings and on Saturdays. The center should also be accessible in the summer time. Two-year colleges should support the necessary travel for their faculty members and the cost of the equipment which the faculty members might use in the development of materials at the center to be taken back to their college for use. Fellowships and grants should be made available for summer work at the center.

THE CHEMICAL INSTRUMENTATION AND LABORATORY CENTER

> A chemical instrumentation and laboratory center for college chemistry teaching is proposed to develop programs, publish materials, and provide a place for faculty members to work with instrumentation and equipment not available at their own college. The center should serve as a stimulus for development of meaningful and interesting laboratory programs for chemistry courses in two-year colleges and it should train chemistry teachers in the use of new laboratory equipment, instruments, techniques and methods.

Many college chemistry teachers need to be up-dated with respect to new chemical instrumentation and how it may be effectively incorporated into their curriculum. To familiarize these teachers with the basic theory of the functioning of various instruments and the practical considerations in the use of these instruments, as well as in curricular applications, they must be provided with an opportunity to work with specific instruments and consider, from personal experiences, the advantages, disadvantages and limitations of the instrument, technique, or method. These faculty members need training in the new techniques. They need to become aware of the operational characteristics and how to calibrate instruments. They need to become proficient in the interpretation of chemical data derived from the use of such instruments.

There is also a need for teacher-developed visual aids and related teaching materials which can be used along with the new instruments in the instructional programs. The equipment budgets of two-year colleges are generally limited and technical support personnel in these colleges is either non-existent or limited in numbers and experience. The faculty members do not have available the necessary time during the academic year to study and become proficient in the uses of such instruments. These reasons argue strongly for a new approach like the proposed center for the improvement of instrumentally related laboratory work in two-year college chemistry programs.

The chemical instrumentation and laboratory center should be concerned with five types of programs; laboratory development, laboratory operation, short courses, instrumental workshop, and publications.

New laboratory programs for beginning chemistry, general chemistry, chemistry for non-science majors, organic chemistry, and analytical chemistry are also urgently sought by two-year college faculty. Students desire laboratory programs which are meaningful and interesting. The center should have a continuous program for the development of new experiments which could be tried out and evaluated in cooperating two-year colleges.

Studies and recommendations related to methods of efficiently operating chemistry laboratory facilities are needed. These should consider planning laboratory facilities, justification and utilization of support personnel, safety procedures, types of laboratory programs for various instructional situations, and the correlation of the laboratory portions of the various chemistry courses.

Short courses devoted to modern chemical instrumentation and instrumental analysis are urgently needed by faculty with "dated" academic work. These courses should include theory and allow the teachers to use the instruments. They should discuss the advances in instrumentation and their application to the teaching of chemistry in the first two-years of college. The courses should be presented in a concise form and at a level that the teacher can understand. The presentation should be commensurate with the type of presentation the teacher will have to make to his students concerning the instrument and its application. A series of short courses in different instrumental techniques (e.g. gas chromatography, infrared spectroscopy, thin layer chromatography, nuclear magnetic resonance, etc.) appears to be preferred.

The Center should also include a central instrumental workshop center for the community colleges in the area. Instructors would come to the center and work with various instruments, either, as a method of training of the instructor in the use of the instrument or as a resource for his teaching. Briefings on the maintenance and repair of instruments available in the local colleges could be held.

Displays and demonstrations of new equipment should be arranged periodically. Instructors would bring students to the instrumental center where they could learn how to use the instrument to perform separations or identifications on materials from their laboratory work using instruments not available to them at the community college.

The center should report and publish new laboratory experiments emphasizing instrumental techniques developed at the center. These reports should include suggestions on how and where to adapt advances in instrumental techniques into the two-year college chemistry curriculum. The center should publish information to provide the faculty with facts and figures which justify and show the value of various kinds and types of equipment. The information could serve as the basis for the development of standards and recommendations for including modern instrumentation in the curriculum. The center should make surveys and publish what is going on with respect to instrumentation in the community colleges and related four-year institutions. This type of information would be useful in developing supporting rationale for equipment grants.

The computer should not be overlooked as an instrument for use in chemistry laboratory programs. The application to chemistry laboratory work and instruction of the small desk top computers, computer-assisted and generated instructional programs, and large computers should be considered.

The chemical instrumentation and laboratory center should operate on a year-round basis. The laboratory development program and the workshop should be available to faculty both during the academic year and the summer. Short courses should be offered on a weekly or monthly basis, one evening a week or on Saturdays. They might also be offered in one week periods during vacations and at the beginning or ending of the summer. Longer short courses would be possible during the summer months.