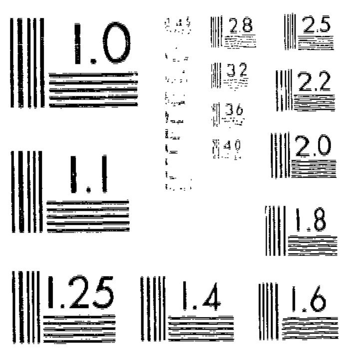

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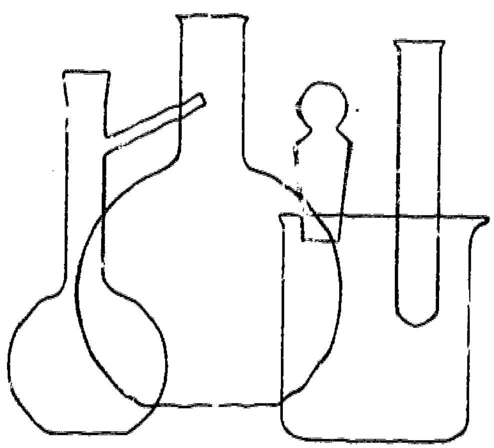
ABSTRACT

This publication, issued twice per year, includes proceedings from Two-Year College Chemistry Conferences and papers of special interest to the two-year college chemistry teacher. Curriculum development in the area of two-year college chemistry is discussed for the U.S. and several other countries. Additional topics include the role of chemistry in general education, chemistry for the allied health student, chemical technology programs, and the use of laboratory instrumentation in chemistry teaching. Various instructional methods in chemistry are discussed, including computer-assisted and individualized instruction. (MH)



CHEMISTRY IN THE TWO-YEAR COLLEGE

1973 NO. 1

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

Foreword

We are happy to bring you this issue and have the opportunity to talk to you. We would like to thank Bill Mooney for all the help he has given us while we put out our first two volumes. His organization and grasp of the total view of the program has contributed invaluable help. At the San Bruno meeting on October 18, 1974, a plaque was presented to Bill in an effort to express appreciation for the leadership he has given during the formative years of $2YC_3$. Again Bill, thank you for a job well done.

At several meetings of the Committee on Chemistry, questions about our journal have been discussed. We would like to speak to some of these problems. As we understand the function of the journal, it is to convey new ideas and approaches in teaching chemistry. For members who attend the meeting it is a permanent record of the meeting and for others it is an opportunity to share the ideas from meetings they could not attend. It is not designed to show Deans that you have attended significant meetings.

Much criticism has been leveled at the lateness of the publications. The fault surely lies partly with us; however, the fact that the journal was without an editor for nearly two years put us behind when we started. It is difficult to get money for more than two publications per year and to date we do not have funds for more frequent publications. Until a few weeks ago we were running nearly a year behind in receiving articles from meeting editors. I have served as a meeting editor and know that it is a hard job to get all of the meeting reports together, nevertheless, we must have them to put out our journal.

We believe that this is a good and important journal and we need your help to keep it interesting and make it current. If you give a paper, please have a typed copy to hand to the editor when you finish your presentation. If you are a reporter get your reports to the editor within one week of the conference. Editors don't wait until you get everything to send us meeting papers, since you probably won't receive all papers. Local editors and chairpersons should both impress on speakers the importance of having a typed copy of their talk ready for the editor.

I would like to thank you for the help each of you have given us and if you have suggestions, please write to us.

Jay & Ellen Bardole
Editors

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Welcome to Ahuntsic College

Roger LaFleur
President, Ahuntsic College
Montreal, Quebec, Canada

Presented at the General Session, the Thirty-Fifth Two-Year College Chemistry Conference, Ahuntsic College, Montreal, Quebec, Canada, June 7, 1973.

As president of Ahuntsic College, I am delighted to bid you all a most cordial welcome in this Institution. It is a privilege and a pleasure for us to play host to our good friends participating in the two year College Chemistry Program, affiliated with the Chemical Education Division of American Chemical Society. I might add that, to a certain extent, we are amongst acquaintances, as undoubtedly some of you will recall that the year your Chemistry Technical Curriculum Project was favoured with an important grant from the National Science Foundation, its symposium on Chemistry Teaching was held at Ahuntsic College, and brought in a large participation of delegates from Europe, the United States and Canada. The United States delegations included your Curriculum Project Director, Mr. Kenneth Chapman.

Chemistry teaching is impossible, without a solid general scientific basis. As we all know, science attempts to obtain a disinterested knowledge of the world of nature. In technology this knowledge is applied to the handling or manipulation of objects. Under the stimulus of recent advances in scientific knowledge and technological devices, the pattern of society is undergoing a revolutionary process. The peoples of under-developed countries now visualize the possibility of a good life for all. They are becoming conscious that science can secure life against destitution and disease. On the other hand, in countries that have attained a high level of scientific and technological development, life expectancy has increased, work loads have been reduced, and the prospect of a leisure civilization for the self-development of all is no longer a remote ideal. More than ever before we can help those who are physically, mentally and emotionally deficient. Man is struggling to shape himself anew that he may achieve the high destiny which life has shown can be his. The wonder of science, what it has done for us, and what it will be for us, is a part of the picture.

Future growth and development will require a far better understanding of human needs, both immediate and future. What is more, it will depend on the willingness and desire of all segments of SOCIETY - BUSINESS - THE ACADEMIC WORLD AND GOVERNMENTS - to participate in meeting those needs.

Unfortunately, at this precise moment we have neither a satisfactory understanding of needs and priorities, nor much evidence of a cooperative attitude towards solving these problems. The various spheres of our society have found it much easier to point at each other and emphasize the neighbour's responsibility. It always seemed incredible to me that three important components of society , namely INDUSTRY - EDUCATION and GOVERNMENT, could not set up some kind of a threesome even if it were only for mutual and selfish interests. The fact is that industry is a leading customer in the two principal products of education: TRAINED MANPOWER AND NEW KNOWLEDGE. At the same time, education relies to a considerable extent on the main product of industry namely: PROFIT.

Consequently a strong educational system cannot exist without a thriving and productive industrial structure, whereas a sturdy industrial organization cannot function without a thriving educational regime. On the same token, a strong democratic nation cannot exist without both.

Ahuntsic College has tried, for a number of years, to work out a practical relationship with industry in an endeavour to keep the industrial sector permanently posted on what is going on in our professional teaching. Contacts have been established, which helped the students and at times, the teachers themselves to up-grade their knowledge of genuine industrial problems.

Recent graduating classes in Industrial Chemistry have not experienced any difficulty in securing employment. As a matter of fact, the demand for candidates always exceeded the number of graduates by approximately 10%. Our cooperation with industry always proved rewarding to us. Several prizes were awarded to students of the graduating classes, for the outstanding quality of their practical work.

Our desire to maintain a first class educational institution has not barred us from participating in the efforts of society to find solutions to more human and alarming problems. In 1971 we organized what was considered a most successful symposium on Education and Environmental Problems, with the participation of reknown experts from Canada, Europe and the United States. This proves that even in a College with a population close to 5,000 students, it is possible, with imagination and hard work, to assume a share of some community problems and make a valuable contribution to the settlement of some major educational difficulties.

On behalf of Ahuntsic College I wish you the best of luck for the success of your congress, and hope your stay with us will be most enjoyable.

Utilizing the Four Faces of Chemistry in General Chemistry

William Masterton
University of Connecticut
Storrs, Connecticut

Presented at the General Session of the Thirty-Third Two-Year College Chemistry Conference, Dallas, Texas, April 7, 1973.

It is a great pleasure to be here. I would like to talk this morning about the applications of chemistry. I think that one of the most important responsibilities that those of us who teach general chemistry have is to point out to the students the applications of the principles that we are discussing.

At the University of Connecticut we have about 1000 students taking the general chemistry course. This is the year course for science oriented people and my estimate is that no more than 5% of these students go on to become chemistry majors. They are distributed among a whole series of disciplines. Perhaps the largest number of them are in the biological sciences, particularly those who are pre-meds and physical therapy. There is another large group who are going to be engineers. The people in the biological sciences and engineering need some indication of how the material we are discussing applies to their areas. We get relatively few people from the social sciences in that general chemistry course.

In stressing the applications of chemistry to these various areas there are some pitfalls that we have to be aware of. For example, just because a student plans to be a pre-med or engineer, I found out, doesn't necessarily mean that he is really interested in biology or even in engineering. I am sure all of you are aware of this tremendous increase in the number of pre-med students that we have had in the past two or three years. The reasons are that this generation of students, more than my generation, is concerned about doing things for people. They are also concerned about getting a job when they get their degree and medicine seems to offer to them a combination of these two opportunities. The problem of course for the pre-med students is that it is so difficult to get into medical school, but presumably if they can survive that hurdle, they won't have trouble getting employment. If you accept that motivation, then it doesn't necessarily follow that they are pre-meds because they really like biology or are particularly interested in biological applications.

The question then is, "How do you work these applications into the general chemistry course?" One very effective way that has been discussed in previous meetings of this group is by laboratory experiments. I won't try to discuss those this morning but there are a great many laboratory experiments that one can do to illustrate the applications of chemistry to other fields and in particularly to the environment. All of these people, regardless of what their principal field is, are interested in the applications of chemistry to the environment; relevance if you want to call it that. This seems to cut across all the students from various disciplines and another way in which you can stress the applications of chemistry of course is by bringing up applications in lecture. I find, at least with my students, that they seem to perk up and show some interest when I try to explain how the principles of chemistry apply to a particular environmental problem whether it is pollution, the energy crisis, or that sort of thing.

There is one danger in attempting to stress too much the applications of chemistry in lecture in that you may distract the student. The students are trying to understand the principle and the application, so one of my favorite techniques, at least for illustrating how chemistry can be used, is to assign problems which have an applied flavor, and if you think about the simple types of problems that we ask in general chemistry, you can adapt a great many of these to some rather practical problems. What I am trying to do is to put together some slides with a few problems that illustrate this sort of thing. I should mention before I do this that I suppose most of you are familiar with a book by Butler and several coauthors on "Relevant Problems in General Chemistry". Even though it is put out by a competitor I can recommend it very highly. It is a very good book and it gives you a lot of ideas.

Slide 1. " A sample of LSD, $C_{24}H_{30}N_{30}$, is diluted with sugar. When a 1.00 mg sample is burned, 2.00 mg of CO_2 is formed. What is the percentage of LSD in the sample?"

This illustrates, I think, a rather interesting application of chemical principles in a rather mundane area, that of chemical analysis. We tend to give problems of chemical analysis where we ask, for example, for percentage composition of a compound. This simply illustrates how the principles that we are discussing can be applied to a problem which of fairly obvious interest. Incidentally it is interesting that when you try to write applied problems of this type they get complicated. When you think about it, this is not a particularly easy problem to solve because both of these compounds contain carbon. You have to take advantage of the fact that they give off different amounts of CO_2 for a given weight of LSD vs sugar and it is a rather interesting problem.

Slide 2. Calculate the average velocities of hydrogen and oxygen molecules at 300°K and compare to the escape velocity from the moon. The escape velocity, Ve, from the surface of the moon is 2.4×10^5 cm/sec. Would you look for H_2 in the atmosphere? O_2?"

This shows an application of the kinetic theory of gases. What we are doing here is calculating the average velocity of a hydrogen molecule at a given temperature, 300°K, then an oxygen molecule and seeing how that compares with the escape velocity of a molecule from the surface of the moon. When I first visualized this problem I was curious because it turns out that the average velocity of oxygen at 300°K is considerably less than the escape velocity from the moon. It turns out that because of the Maxwell-Boltzmann distribution of molecular velocities, if as few as one fifth of the molecules have a velocity equal to the escape velocity, then within a relatively short time those fast moving molecules will escape. Unless the velocity is less than one fifth of the escape velocity, essentially all of a gas will escape in 10^9 years of less. So again this is a problem that has to be modified a little bit to make it apply. It wasn't quite as simple as I thought when I first started looking at it.

Slide 3. "Each day a power plant takes in 2.0×10^6 kg of water at 25°C from a river and uses it to condense 50,000 kg of steam. What will be the temperature of the discharged water?"

This slide shows an application of H of vaporization. When we are talking about phase changes we often put in problems of the type if so and so many grams of steam condenses, how much will that raise the temperature of a sample of water? It is relatively easy to apply this to a thermal pollution problem which is what we have done here to see how much a cooling unit in a power plant will actually raise the temperature of a river into which it is discharging water.

Slide 4. "The osmotic pressure of 1.0 g of hemoglobin/ 10 ml is 2.75 mm Hg. What is the molecular weight of hemoglobin?"

This is a fairly obvious application when we are talking about colligative properties and osmotic pressure in particulat. I think it is worth pointing out to students that the measurement of osmotic pressure is an extremely useful way of determining molecular weights of biological weights of biological materials and this happens to be hemoglobin, but it can be applied of course to a wide variety of materials including high polymers. It is the classical way of getting molecular weights of these very high molecular weight species and this simply points out one application.

Slide 5. "The H of activation of a reaction is 10.0 kcal. By what factor is the reaction rate increased when at 104° F assuming 98.6°F is normal?"

This is an interesting one. When you talk about kinetics in general chemistry you refer to activation energy and all I have done here is to take the Arrhenius equation and take the two temperatures to be body temperatures and a rather high fever, 104° is pretty high, but it turns out it has to be about that to get a reasonable activation energy, and the students simply substitutes into the Arrhenious equation and calculates the increase in the rate of reaction. I think, as I re-all, it is an increase of about 20-30%.

Slide 6. "Hem $(O_2)_{(qg)}$ + $CO_{(g)}$ Hem $(CO)_{(g)}$ + $O_{2(g)}$ $K_c = 210$ Calculate the fraction of hemoglogin in the CO form in a person breathing polluted air in which the CO concentration is 4×10^{-6} M and the O_2 concentration is 8.5×10^{-3} M."

When we start talking about chemical equilibrium in the general chemistry course and the idea of an equilibrium constant, we sort of search around for an equilibrium of this type in which all the coefficients are one because the arithmetic turns out a lot simpler in that case and here is an example of such an equilibrium which happens to have considerable biological importance, the equilibrium between the oxygen complex of hemoglobin and the carbom monoxide complex of hemoglobin. You can relate this to the percentage of carbon monoxide in the air which is toxic. It turns out if you make this calculation that under these conditions: CO 4×10^{-6} M and O_2 8.5×10^{-3} M, that is the concentration of oxygen in ordinary air and the CO concentration in rather strongly polluted urban air, the fraction of hemoglobin in the CO form is of the order of 20% which is relatively high. You can in turn relate this to the level of CO that will give you either short term poisoning or permanent damage on exposure for a long period of time.

Slide 7. "Consider the body as a heat engine and determine the thermal efficiency of heat energy converted to work."

$$E_{ff} = \frac{Ta - Tr}{Ta}$$

Suppose the body acts as a heat engine burning food to produce useful energy. Use the second law equation of thermodynamics to calculate the fraction of heat converted to work when the outside temperature is 72° assuming now that the Ta, the temperature at which the heat is being absorbed, is simply body temperature. If you make this calculation, you come to the conclusion that under these conditions the efficiency would be of the order of 5%. In other words for every kilocalorie of heat due to food about 50 calories of useful work would be obtained. If the body really operated that way you would have to eat an enormous amount of food to do even a small amount of exercise. The body of course is not a heat engine. Indeed you can extrapolate this calculation to come to the conclusion that it would do you no good at all to eat food to produce energy on a day when the temperature was above 98.6°F. You would have a negative efficiency. The problem is that the body isn't a heat engine. The body is a very effective way of converting through metabolism processes of converting chemical energy directly into mechanical energy without going through heat which this type of calculation connotes.

These are a few examples of the sorts of ways in which you can adapt the principles of chemistry to quantitative problems that, I think, interest the student. Too often I think, the kinds of problems that we give students in general chemistry are so cut and dried that the student feels that they are a rather sterile exercise that we are forcing them to do and I think too often they fail to realize that the problems are supposed to illustrate some really practical applications that they should be aware of.

Chemistry: A Cultural Approach

W.F. Kieffer
College of Wooster
Wooster, Ohio 44691

Presented to the General Chemistry Section, the Thirty-Fourth Two-Year College Chemistry Conference, Cuyahoga Community College - Metropolitan Campus, Cleveland, Ohio, May 11, 1973.

Culture can be defined broadly as all the products of human thought and work, the beliefs of a generation that are transmitted to the next. We know that science and technology are a part of this heritage that we have received and that we will pass on in even more fully developed form. I feel strongly that we have an obligation for the future citizens who will not be professionally related to science to recognize what the contemporary roles of science and technology are. Moreover, I am convinced that the attitudes toward the appreciation of, and the understanding of scientific concepts will have more lasting influence on the way these students will live than does the information, the mere facts, we try to cram into their already cluttered brain storage systems.

A first course for such customers cannot be a mere watered down survey of chemistry. Rather, the course should concentrate on some area of chemistry about which the professor has both thorough understanding and enthusiasm. Enthusiasm is the essential ingredient for making the course interesting for students.

Whatever the subject used to illustrate the essential rationality of the scientists' methods, it can be illuminated by examples the student already sees as relevant. I like to carry through the phlogistonist's struggle to explain the burning of candles and Lavoisier's more inclusive concept of oxygen's role in combustion. But the important conclusion of the discussion includes LOX in space vehicles and eutrophication. In a similar manner, the second law of thermodynamics, that glorious triumph of human intellectuality, remains rather sterile if no mention is made of thermal pollution and the problems associated with utilizing any low temperature source of heat energy. The important concept of equilibrium and the influence of temperature, both on the equilibrium and on the kinetics of effecting attainment of equilibrium, can be illustrated elegantly and interestingly by the nitrogen-oxygen-nitric oxide system. The production of NO in the atmosphere by lightning and the kinetic freezing of the high temperature proportions at low temperatures has, for eons of time, ultimately enriched our universal resources. Yet at present, these same conditions created by high temperature internal combustion engine exhaust leads to the harmful effects of photo-chemical smog.

An important attitude that should be stressed for these students is that the questions rather than the answers are the essence of the scientist's approach. Whatever laboratory experiences these students have should not be restricted merely to confirming "what they are supposed to get." At least some should be open-ended. Similarly, the demonstrations (and there should be some every day) should be accompanied by questions. One of the highest compliments paid my course is its characterization as the "I show - you tell" course. I often use the device of having the explanation of a demonstration be a part of a quiz or examination.

I do not think this course need be completely devoid of arithmetic. Quantitative expression is essential to the scientific-technological enterprise. The mathematics need not be elaborate. The simple but concise concept of translating a proportion into an equation by utilizing a constant of proportionality is the level I am talking about.

Probably the essential idea I am trying to express is that this course for non-science majors demands that we focus on educating rather than merely training, as we can so often get away with when future chemists comprise the class. This is why the emphasis should be more on concepts than information. This also is why science and technology always appear interwoven - as they do in our contemporary civilization. Unless future citizens realize this, there is little hope for changing the laissez-faire attitude toward technology that has led us into our crisis confrontation with our resources and environment. Hopefully, the future generation represented by those students in our classes will have wisdom. But wisdom has to be based on knowledge. Helping students to gain that knowledge is our privilege and opportunity.

Instructional Methods in Chemistry

The Development and Implementation of a Computer Assisted Laboratory

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Presented to the General Chemistry Section, the Thirty-Fourth Two-Year College Chemistry Conference, Cuyahoga Community College - Metropolitan Campus, Cleveland, Ohio, May 11, 1973

Teaching in a community college is both a challenging and very exciting experience. The students reflect a mixture of talents, interest, and abilities. So it came as no surprise to us that we found motivated, experienced laboratory students working side by side with inexperienced students who sometimes could't spell "laboratory" let alone perform most ordinary laboratory manipulations and calculations. Often we instructors found ourselves spending most of our time working with the inexperienced students to show them how to do their ordinary laboratory work. We felt that this necessary effort often curtailed our availability to the experienced student, especially if that student required some help or advice in doing the calculations based on his experimental data. The ideal situation would have been for the student to complete both his laboratory work and the accompanying calculations before leaving the laboratory. This would reinforce laboratory concepts more fully, especially if he could be assured that all his work was correct.

What really was happening was this: The experienced student normally finished his work quickly and left the lab early. He would do his calculations later in the week. The inexperienced student would barely finish, with the result that he too would have to do his calculations later. This meant that any work would be handed in after one week. By the time the work could be graded and returned, a second week would have passed. Needless to say, maximum educational reinforcement did not take place this way. By the time the student became aware that he had made an error (in procedure or calculations) it was not only too late to correct it, but due to the two week delay he probably had forgotten about the details of the experiment.

1. Development of Computer Assisted Laboratory.

The development of our present program occurred in several stages as was dictated by the changing nature of our computer facilities.

The first stage of development occurred at a time when the campus IBM 360 model 30 was underused and a red carpet invitation was extended to faculty. This enabled the processing of both a student and faculty print-out sheet before the end of each laboratory period. The program uses the student's data and proceeds step-wise through the calculations to give the final results which the student should obtain if he has not made any errors in his calculations. The faculty print-out sheet gives the compilation of data and the final students results

The advantages of the Computer Assisted Laboratory (after this to be referred to as CAL) were as follows: The students were able to see correct calculations derived from their data by the end of the laboratory period, or in some rare case of delay, within a one week period. This enabled the instructor to spend more time in correcting the student errors rather than checking through the student's arithmetic. More profound was the deepening of student interest, which resulted from the student-faculty discussion of printed results.

The faculty print-out sheet in addition to giving a compact record of student performance, also served as an excellent diagnostic tool to locate systematic experimental errors. For example, during a specific heat type of experiment, it was noted that the results of the first laboratory section were acceptable, but that ensuing laboratory sections showed a consistant error. This error was then able to be traced to an insufficient drying of the metal samples.

This stage of development ended when increased administrative use of the computer system began to tie up both the machine and the key punch operators. Eventually programs were processed on a submittal basis and the return time for the student and faculty print-outs was increased up to two to three weeks. Needless to say, this cancelled any educational advantage.

To relieve the tightness of the IBM 360 schedule, a Hewlett Packard Mini Computer 2000B and terminals were rented. This prompted the development of stage II of CAL. Programs designed to perform calculations using student data were written in the BASIC language. After completing their laboratory work and calculations, the students were able to log onto the computer via a terminal located in the laboratory and recall the programs from a stored library. After inputting their data according to the program requested format, they could observe instantaneously a print-out giving the correct answers. Good experimental results were praised and inferior results discouraged by means of a printed message. If the print-out showed a calculation error, a student would be able to recalculate and check his work. Where experimental error existed, it could either be corrected in the remaining laboratory time or in specially scheduled "Make-up" laboratory periods. There was one disadvantage noted in this process. An occasional student would simply take the correct answer given by the print-out and "parrot" it back in his laboratory reports. This prompted a further development of CAL.

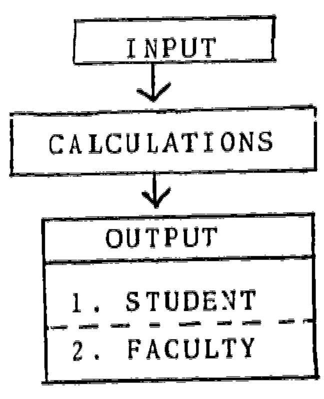
The programs were modified so that students would input not only experimental data, but also the data obtained from sequential calculations as well as their final result. This permitted not only the checking of the final result with the acceptable programmed answer, but also provided for a check of each of the sequential calculations. This meant that the student would be informed of the correctness of his endeavors at each step in the calculation procedure. If a calculation error occurred, he would be notified and given an error message and a diagnostic hint that would direct him to make appropriate corrections. Although these additional program features increase the terminal time required for each student, the time element remains acceptable, about three to four minutes for each student. It would only be fair to tell you at this point that every so often a terminal does get dented by an irate student discontented by repeated error messages.

One further addition, an executive filing system used to produce a faculty print-out sheet was tested during the present semester. The system functions well, however, software complications of our new Hewlett Packard Model 2000E occasionally dump core into the programs. This software problem will hopefully be corrected when the present model is replaced by the more compatible Model 2000-C. We would summarize the educational advantages of CAL at its present stage of development by one expression, "increased student motivation". It is not an uncommon occurrence for students to go back to the laboratory after using CAL and voluntarily redo their laboratory experiments in an effort to get better results.

II. Implementation of CAL.

Now let us turn our attention to the implementation of CAL. You'll recall that Fortran programs were used in the first stage. The programs themselves employed relatively simple program logic:

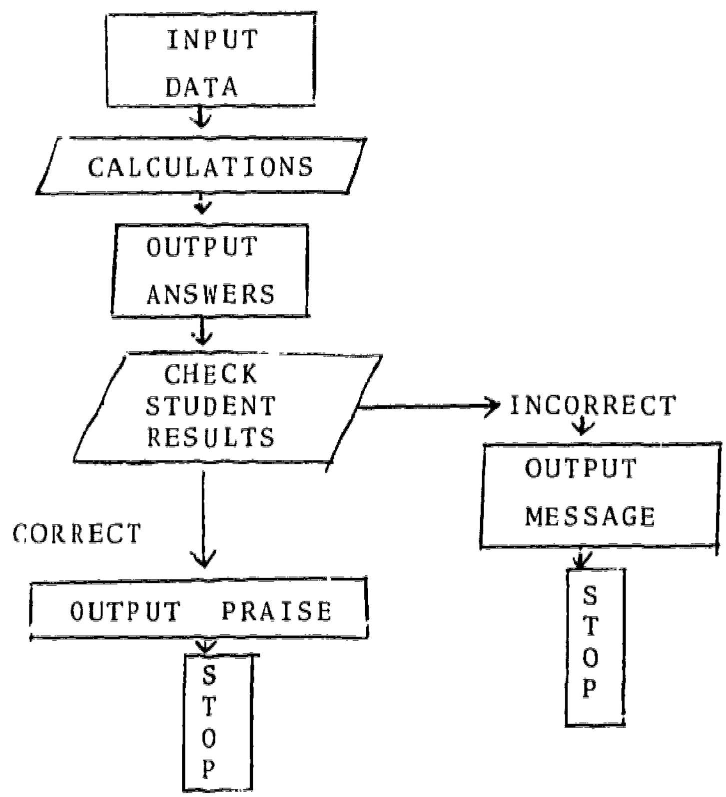
FLOW CHART



Each program consists of an input section, a calculation section, and two outputs (one for the students and one for the faculty). Now let us examine the content of one such program.

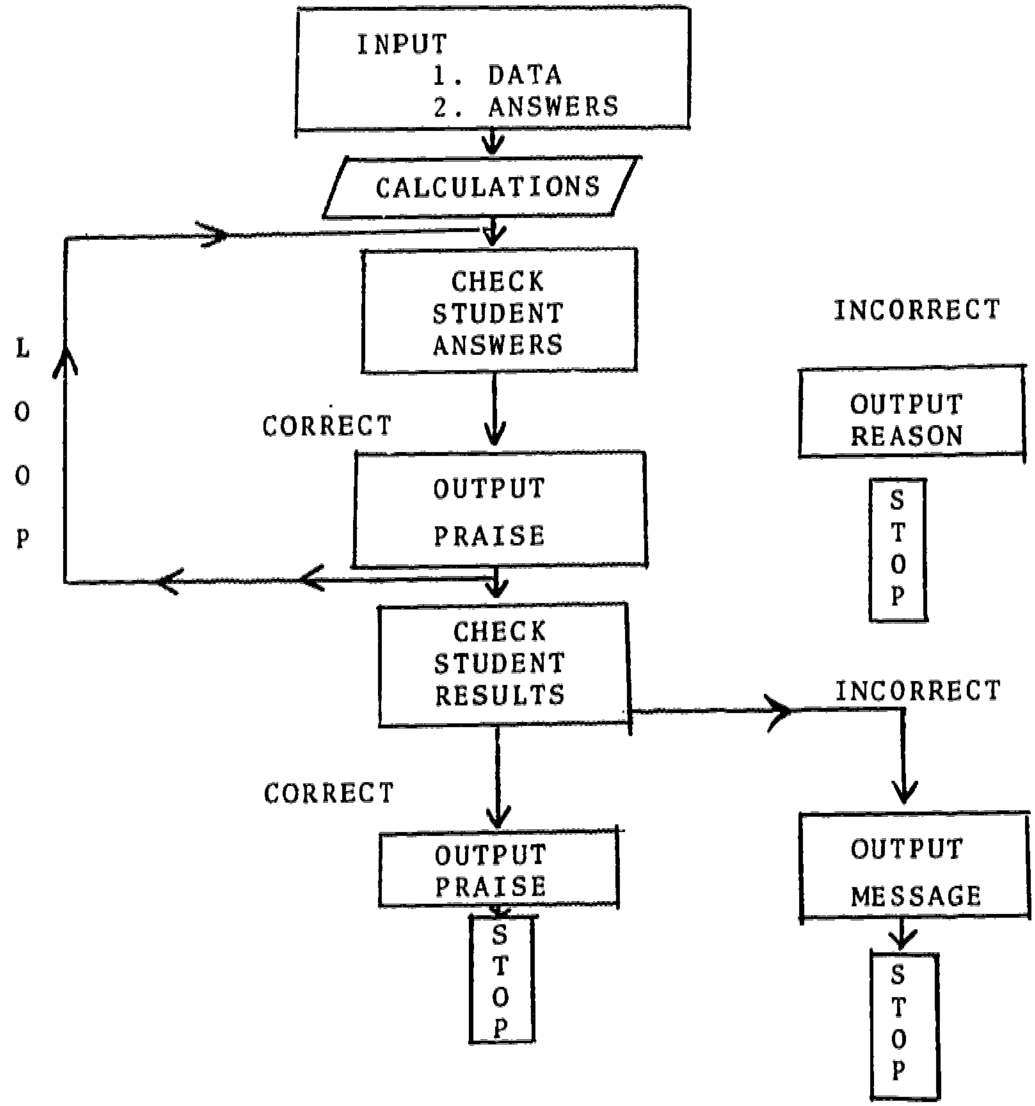
The first section reads the student data. The next section (equations) does the calculations. The third section (WRITE) writes the student print-out sheet. The last section (WRITE) produces the faculty print-out. The student data were collected by means of a class data sheet which a key punch operator transferred to data cards. These were then inserted into a Fortran deck and processed.

When CAL was transferred to the time sharing system, student use of the programs became more direct. The students in this procedure now logged on to the computer via a teletype located in the laboratory. They were instructed in "log-on and log-off" procedures and the system's diagnostic messages. Special data and calculation sheets were provided to enable the student to organize their calculations and data in a systematic manner.



Like the Fortran programs it contains an input, a calculation, and output section. It includes, in addition, an option which checks the student's results. Correct results are rewarded with a praise message and incorrect results are rewarded with a negative response. The student data are requested individually, each result is then printed and calculated. Calculations are performed and compared to theoretical results and judgment is passed on the acceptability of the student data.

Whereas stage II of CAL simply checked the student data, the third stage was designed to check their data and calculations.



The input now includes both data and answers, whether intermediate or final. After the computer finishes the calculations, a loop is used to check each step of the calculations. A student error causes a branch in the program which ceases execution, prints an error message, and a diagnostic message. Correct calculational steps are praised and execution proceeds until all the calculations are successfully checked. Then as in the previous stage, the final student result is checked. If the student and the computer results agree within three percent, an agreement message is printed. If the final calculation agrees, the student is given an extra pat on the back. A larger discrepancy results in the printing of a disagreement message and a diagnostic message varying with the type of mathematical operation performed in a given stage of calculation. If all the student calculations are in agreement with the computer calculations, the final student answer is then compared with the theoretically determined answer. Serious variation between the two answers result in a message that tells what is wrong with the student result and suggests a way to experimentally improve the data.

The final stage of CAL was designed to obtain a faculty print-out similar to that produced by the early Fortran programs. An executive file was established. The program for each experiment was treated as a file and each file was divided into twenty-four records which represented assigned student locker number. Each record was subdivided into the appropriate number of laboratory sections. An executive file was written. The log-on section of the file programs requires that the student input his course section number, his locker number, and the number of the experiment he is performing. Control is branched to the CAL program indicated in the log on procedure. The first part of the program reads the record based on the student's locker number. That student's portion of the record (based on his section number) is up dated while the student uses the program for that experiment. Then the up dated record is then printed back into the file. As the student is using the experimental program, his portion of the updated record is then printed into the file. Information may be retrieved from the file by using an output program.

A key program is used so that only faculty can gain access to the file and file programs. In addition, two output programs were developed. Both read the file, but output it differently. LIST outputs the file by laboratory sections and FILIST outputs the entire file by record.

III. Evaluation of CAL.

Due to the changing nature of CAL, it has been impossible to carry out a rigorous statistical evaluation. In two to four years we should be able to do so. The only evaluation we have at the present time are the students and faculty comments which have been sufficiently favorable to encourage the continued development and use of CAL. The efficiency of any system that uses a computer is only as efficient as the computer it uses. Our present computer is fairly stable and the efficiency of using the CAL programs is adequate. However, the system is not yet sufficiently stable to use the executive filing stage of CAL.

At this time I wish to thank Mr. William Conry, our computer system coordinator, for his encouragement and assistance in the development of CAL and the Executive filing system programs. Also I wish to thank Dr. Martin Volkar and Mr. Michael Fezar for their helpful suggestions in preparing this paper. And finally I wish to thank the Community College of Allegheny County for supporting a portion of the development of CAL by means of a summer research grant.

Utilization of the Sadtler Audio-Visual Materials to Prepare The Students for using Instruments

Eleanor Roach
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Presented to the General Chemistry Section, the Thirty-Fourth Two-Year College Chemistry Conference, Cuyahoga Community College - Metropolitan Campus, Cleveland, Ohio, May 11, 1973.

Muskegon Junior College, Muskegon, Michigan, started in 1927, was a two-year college transfer school. In 1951 the name was changed to Muskegon Community College and technical-vocational terminal programs were added. We have an enrollment of about 2500 full time equated students. In Chemistry we have approximately 150 General Chemistry students, 60 Nurses Chemistry students, 24 in Preparatory Chemistry, 24 in Organic Chemistry, and 15 in Quantitative Analysis. Second semester General Chemistry Laboratory is Qualitative Analysis.

We have used Keenan and Wood as a text in General Chemistry for three years, Morrison and Boyd for Organic Chemistry and Roberts, et al. for Organic Laboratory.

Our students do well on transfer, attaining the same or better grade point average as at Muskegon Community College. One of our former students is in Dental School at the University of Michigan after two years of pre-dent preparation at Muskegon Community College, Another is a junior at Michigan State University and has been accepted for the University of Michigan Medical School next fall.

At Muskegon Community College we have a Perkin-Elmer 700 Infrared Spectrophotometer, two Gow-Mac Chromatographs and a Jerrell-Ash Atomic Absorption Flame Emission Spectrophotometer, all purchased within the last three years. This coincides with the acquisition of a new President at Muskegon Community College who is interested in modernizing curriculum and teaching methods.

In December 1972, we were given a Beckman UV-Visible, double beam grating spectrophotometer in excellent condition by a Muskegon Chemical Firm. We have requested an NMR Spectrometer for next year.

Two years ago there were funds available under Title VI and the chemistry department recommended the purchase of Sadtler Audio-Visual Materials in Basic Infrared Spectroscopy, Basic Gas Chromatography and Basic Atomic Absorption Spectroscopy. We have used these during the 1971-72 and 72-73 school years.

In general Chemistry we have presented the first program in Basic Infrared Spectroscopy, Instrumentation, during the teaching of the chapter on Spectroscopy and Molecular Structure. Laboratory time was used for a demonstration actually obtaining an IR spectrum with our spectrophotometer.

We have presented the first program in Gas Chromatography, Basic Relationships and Instrumentation, in discussing the colloidal state.

In organic laboratory the first four programs in Basic Infrared Spectroscopy, Instrumentation, Liquid Sampling Techniques, Liquid Sampling Devices, and Solid Sampling have been presented during laboratory periods. This permits time for questions and discussion of the material shown.

The fifth and sixth programs, Quantitative Analysis, Part I--The Beer-Lambert Law and Part II--Performing the Analysis, have been presented in Quantitative Analysis Those students who have not had Organic Chemistry must start with the first program. All the programs are available for individual student viewing at their convenience.

Organic Chemistry Laboratory and Quantitative Analysis use all six programs in Basic Gas Chromatography: Basic Relationships and Instrumentation, The Column--It's Make-up, Selection and Use, Sample Preparation, Derivatives and Sampling Techniques, Column Temperature and Temperature Programming, and Qualitative and Quantitative Analysis.

In organic laboratory we have used Gas Chromatography for analyzing reaction mixtures in organic preparations. The students are required to review all the Gas Chromatography programs before they can use the instrument for analysis of samples.

In Quantitative Analysis each student does at least one experiment using gas chromatographic techniques. The Audio-Visual programs are available for individual student use and must be viewed before instrumental analysis is permitted.

Basic Atomic Absorption Spectroscopy consists of four programs; Principles of Atomic Absorption, Instrumental Requirements; Instrument Conditions and Sample Preparation.

In Quantitative Analysis students use these Audio-Visual materials individually. These students do different individual experiments and they must view the programs before being introduced to the use of the instrument, then proceeding with the assigned experiment. The instructor does not have to give individual instruction of the material covered in the programs. Many students go back to the Audio-Visual Programs after having done the instrumental analysis to check the theory and techniques presented.

The Sadtler audio-visual material is presented in units which can be studies by the students individually at their own convenience. A Teacher's Guide with helpful information is also available.

Each unit program consists of 35 mm slides (or film strips) and audio cassette tapes providing explanation and description. There are summary slides at intervals to help reinforce information. The length of the programs varies from 20 to 29 minutes. Some programs are a little long to hold the attention of the student.

Rather than showing a program as a unit, an instructor can select slides to demonstrate one particular idea or technique and prepare his own commentary to accompany the slides.

Some of the students have asked for a written trans-transcript of the cassette tapes. Some have difficulty correlating the tape with slides or especially film strips when going back to review a particular slide or group of slides. It is difficult to find the right place on the cassette tape that corresponds to the particular slide you are interested in seeing again.

L'Emploie De La Télévision Pour L'Enseignement De La Chimie: Parallele Entre Deux Methodes D'E.T.V.

Jean-Pierre Masse
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Presented at the Symposium on Innovations in the Teaching of Chemistry, the Thirty-Fifth Two Year College Chemistry Conference, Ahuntsic College, Montreal, Quebec, Canada, June 8, 1973.

Il y a deux ans, à la suite de plusieurs essais dans le domaine de l'enseignement télévisé, le département de chimie du CEGEP de Trois-Rivières fut amené à produire une série de 12 emissions de télévision, illustrant le cours de chimie 101.

Les objectifs poursuivis étaient de faciliter l'appretissage de certaines parties du programme par le truchement de la télévision. De plus, la méthode E.T.V. proposée devait motiver l'étudiant a faire luimême certaines demandes pour l'acquisition de nouvelles connaissances.

Cette méthode E.T.V. prévoyait l'agencement des activités pédagogiques à l'interieur d'une semaine de la facon suivante:

1. Activite	Cours Introduction	50 min.	Cours donne en classe devait introduire le programme de la semaine.
2. Activité	Cours T.V. ou exercices	30 min.	Cours donné à la télévision était constitue d'un condensé de la matière à être vue durant la semaine. Un document d'accompagnement présentait un plan du cours T.V.; des questions indiquaient à l'étudiant les points importants à retenir.
3. Activité	Cours Conclusion	50 min.	Cours donné en classe par le même professeur du cours introduction mais différent du professeur du cours T.V. Ce cours devait être une période où l'on pouvait discuter des problèmes provoqués ou proposés par le cours T.V.
4. Activité	Laboratoires	2 pér. 50 min.	Pas de directives particulières.

Nous avons pu constater par l'évaluation qu'à partir de certaines mesures dans le domaine de l'acquisition des connaissances que les résultats étaient aussi bons pour les groupes ayant un enseignement utilisant la télévision que pour les groupes ne l'utilisant pas. Cependant, nous avons remarqué qu'à la suite de plusieurs sondages, les étudiants étaient plus ou moins frustrés par cette méthode d'enseignement. En effet, les étudiants étaient insatisfaits d'un certain nombre de choses. Entre autres, ils trouvaient que les cours T.V. étaient trop denses et qu'ils étaient donnés avec un débit trop rapide et alors on manquait de temps pour prendre des notes.

D'autre part, nous avons eu beaucoup de difficultés à coordonner les objectifs poursuivis par les professeurs des cours introduction et conclusion avec les professeurs des cours T.V. De plus, les cours T.V. proposés ici faisaient abstraction des variations individuelles sur la capacité, l'intérêt, le rythme d'apprentissage. Le "feedback" attendu au niveau du cours conclusion fut décevant du fait que les étudiants sentaient davantage le besoin qu'on reconnaît à réexpliquer le contenu du cours T.V. plutôt que d'en faire une discussion.

Dans le cadre d'un mémoire de maîtrise en pédagogie que je présente actuellement à l'Université du Québec à Trois-Rivières, on a élaboré une nouvelle méthode d'enseignement qui aurait pour objectifs, entre autres de corriger les diverses lacunes laissées par la première méthode tout en facilitant une certaine individualisation de l'enseignement où les étudiants pourraient en quelque sorte choisir une partie de leurs cours qu'ils verraient au moment opportun, selon leur motivation.

La méthode peut se distribuer soit sur 1 semaine ou 2 semaines d'activités pedagogiques, selon les exigences du programme académique. En voici un diagramme.

1° Semaine

1° Activité
Obligatoire
(Période fixe)
(Local fixe)
50 min.

2° Activité
Facultative
(Période au choix de l'étudiant)
10 à 15 min.

3° Activité
Obligatoire
(Période au choix de l'étudiant)
30 min.

4° Activité
Facultative
(Période au choix de l'étudiant)
10 à 15 min.

5° Activité
Facultative
(Période fixe)
(Local fixe)
jusqu'à 50 min.

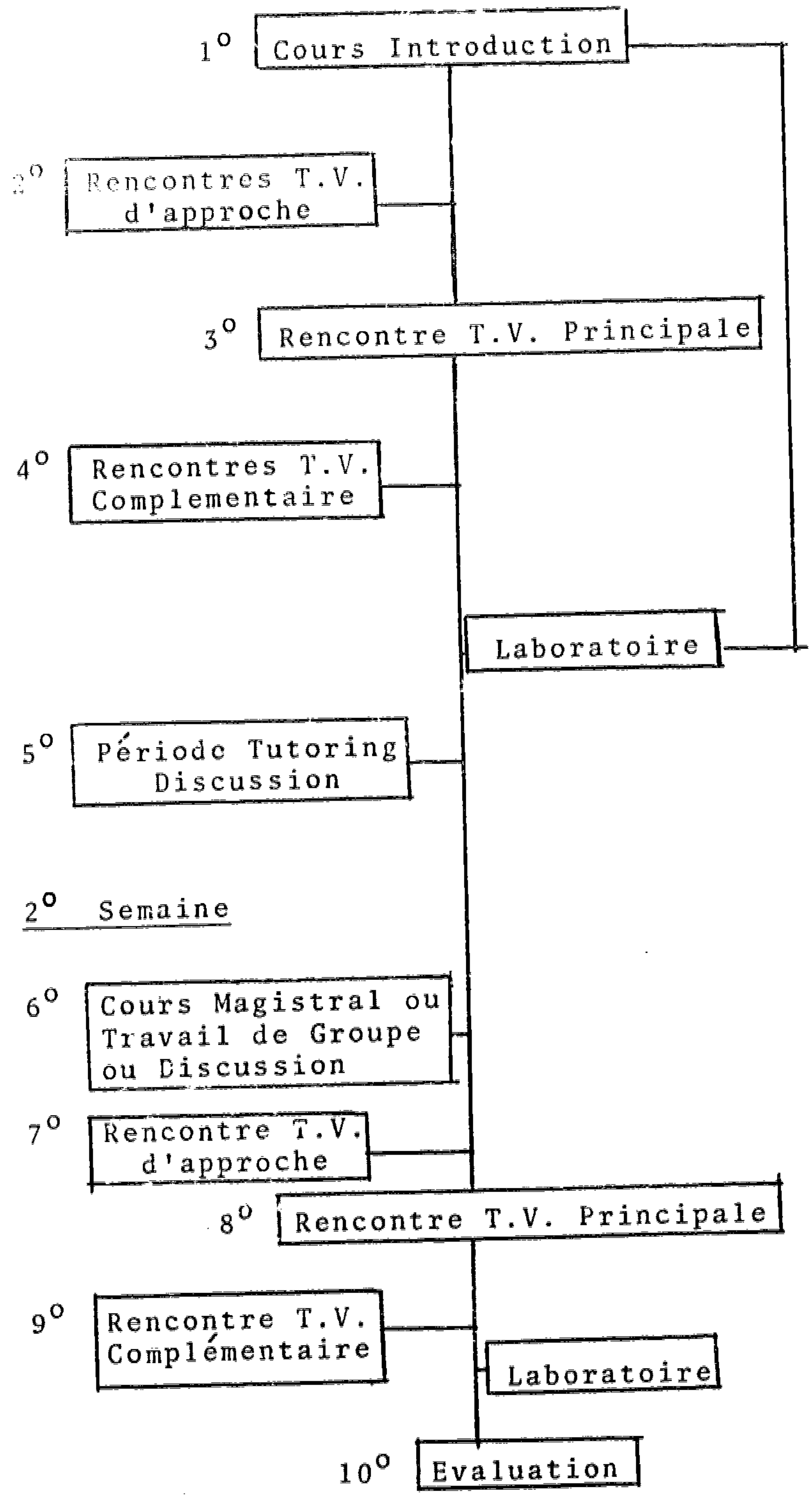
6° Activité (1°)
Facultative
(Période fixe)
(Local fixe)

7° Activité (2°)
Facultative

8° Activité (3°)
Obligatoire

9° Activité (4°)
Facultative

10° Activité (5°)
Obligatoire



Les objectifs méthodologiques de chaque activité sont:

Cours Introduction:

- Introduction aux différentes activités des deux semaines à venir (ou 1 semaine)
- Mise en place des prérequis au programme des deux semaines.
- Introduction au programme des deux semaines.

Rencontres T.V. d'approche:

- (Il peut y avoir, au choix, plus d'une émission. Cela dépendra des possibilités offertes par le programme.)
- La liberté de voir cette émission est suggérée par le document d'accompagnement sous forme d'un questionnaire.
- Approfondissement des prérequis afin d'assurer une meilleure compréhension du programme à être vu aux cours T.V. principaux.
- La didactique prévoit une série d'exercices où le médium T.V. peut exceller comme guide.

Rencontres T.V. principale:

- Document d'accompagnement micro-gradué où des espaces sont à compléter lors de la <u>participation</u> à la recontre T.V.
- Dialogue entre le professeur T.V. et le télétudiant amenant ce dernier à une démarche intellectuelle constante et intensive.
- Constitué de la partie du programme de la semaine demandant à être vu et compris de tous les étudiants indépendamment de leur concentration.
- Ceci est, en fait, le tronc commun du cours.

Rencontres T.V. complémentaires:

- (Il peut y avoir au choix plus d'une émission.)
- Partie du programme qui peut être soit obligatoire ou facultative dépendamment des exigences des programmes de certaines concentrations.

- Partie qui peut être considérée comme un enrichissement.
- La didactique de ces émissions est la même que celle utilisée pour la rencontre T.V. principale.

Période de tutoring ou de discussion:

- Période libre de "feedback" où l'étudiant vient au professeur s'il le désire.
- Ce n'est pas une période où l'on réexplique le contenu des émissions mais une période où on aide l'étudiant à faire les exercices demandés.

Evaluation:

- Sur deux plans:

  1° plan: Etudiants ayant vu la Rencontre T.V. Principale indépendamment s'il a vu la Rencontre T.V. d'Approche.

  L'evaluation se fait sur la partie du programme couvert par les deux émissions et sa note peut être de $\frac{x}{x}$

  2° plan: Etudiants ayant vu toutes les émissions de T.V.

  L'évaluation se fait de la facon suivante:

- Pour les deux premières émissions, sa note peut être de $\frac{x}{x}$ bonnes.
- pour le contenu de la 3° émission sa note sera calculée par rapport au nombre de questions répondues, soit pour "y" réponses fournies, une possibilité de $\frac{y}{y}$ bonnes.

  Pour un total de $\frac{x+y}{x+y}$

- Il est à noter ici que l'étudiant n'est pas pénalisé s'il n'a pas répondu à certaines questions de la 2° partie de l'examen.

30

Lors de l'experimentation de cette méthode durant une semaine sur des groupes, des mesures furent prises pour l'application d'un prétest et d'un postest. La différence obtenue entre ces deux tests fut comparée aux résultats des groupes qui n'avaient recu qu'un enseignement traditionnel durant cette même période et pour le même programme. Les résultats démontrent que la rétention de connaissances académiques est statistiquement équivalente dans les deux groupes démontrant que sur ce plan l'enseignement par cette nouvelle méthode est aussi rentable que l'enseignement traditionnel.

Par contre, des avantages marqués sont à souligner: le professeur allant moins souvent en classe est plus disponible aux étudiants; ces derniers devant décider eux-mêmes s'ils assistent à la dernière période en classe sont obligés de s'autoévaluer de facon continue.

Cependant, les résultats ne sont pas les mêmes sur le plan affectif. A un sondage par questionnaire, les résultats demontrent un très grand enthousiasme pour la nouvelle méthode. En effet, les étudiants semblent goûter énormément la possibilité qui leur est offerte de choisir eux-mêmes le programme qu'ils aiment et trouvent facile de se servir du document d'accompagnement tel que conqu. En plus de préférer cette nouvelle méthode à l'ancienne T.V., ils la préfèrent à l'enseignement traditionnel.

Devant de tels résultats, le département planifie actuellement la production d'une nouvelle serie d'émissions basées sur cette méthode visant à la satisfaction des étudiants pour assurer la plus grande rentabilite de notre enseignement. Ce qui est important au fond, ce n'est pas de savoir si la rétention immédiate va être la même mais c'est de savoir que les étudiants aimeront étudier et seront motivés davantage à l'intérieur d'un cadre qu'ils choisiront eux-mêmes.

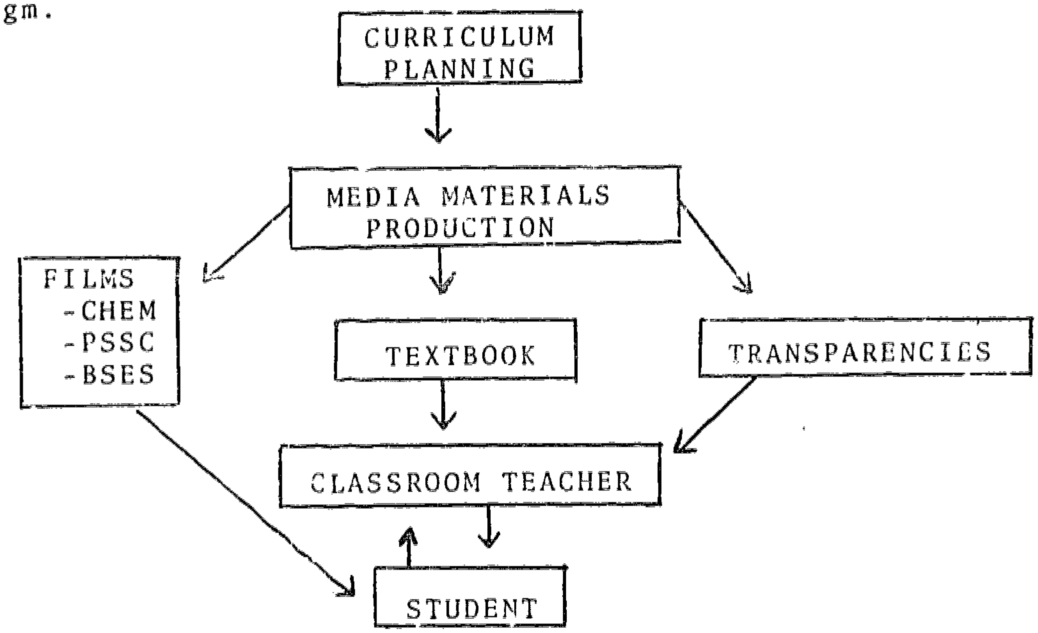
The Use of Sixteen Millimeter Film in Team Teaching and The Production of New Material from Existing Sixteen Millimeter Film

Maurice Dupre
University of Montreal

Presented at the Symposium on the Innovations in the Teaching of Chemistry, The Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 8, 1973

The new field of Educational Technology is making us aware of the "Systems Approach" to the teaching of various subjects in the curricula of our schools, colleges, and universities.

The traditional position of the classroom teacher is that of interpreter of the materials of instruction; textbook, transparences, slides, etc. Film strips with their built in text and often accompanying sound track, and especially sound films, have been considered both by the producers and the teachers utilizing them as "packages of mediated instruction" wherein, the "media teacher", i.e. the film, communicates directly with the student according to the following paradigm.

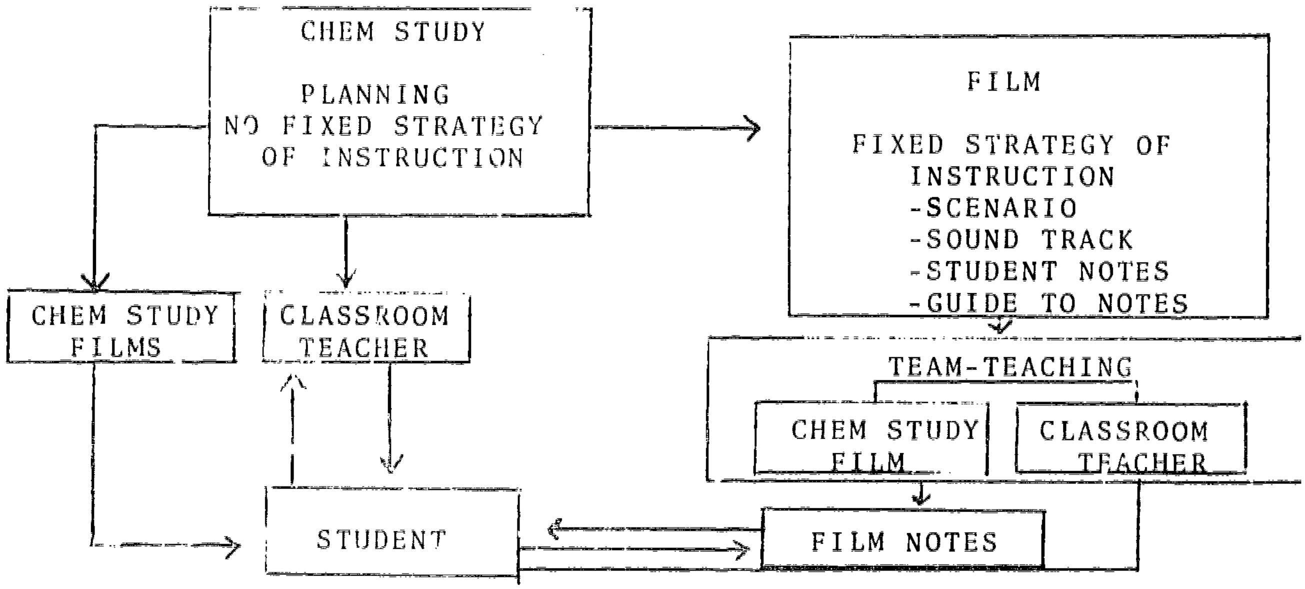


We advance here that it has been a falacy to state that the CHEM Study films are "packages of mediated instruction" where, from a systems point of view the film has been assigned one set of instructional tasks and the classroom teacher another set.

Our work with 20,000 French language students and their teachers in the province of Quebec, Canada has proved that a new approach in the use of films in the classroom is possible and prone to an 80% adoption.

A hint as to the need of interpretation and possibilities of Team-teaching with CHEM Study film is found in two of the 30 CHEM Study films. In the first " Gases and How They Combine" the mediated teacher, Dr. Pimentel, suggest to the audience that the projector be turned off and that a class discussion take place around the data accumulated in the preceding experiments. Then again in the film "Vanadium-A Transition Metal", the mediated teacher suggest that the projector be turned off and that the students work out the electronic configuration of the element.

In the retraining of chemistry teachers for the teaching of CHEM Study and the use of CHEM Study films we have systematized the method of using films with the assumption that interpretation is essential. We now see that the voluntary adoption of a fixed strategy of instruction is as outlined in the right hand side of the following paradigm.



The question now before us is how does one interpret a film or Team-teach with a film.

Two new tools must be added to the film: the first a student workbbook" or notebook and the second a detailed teacher guide. The content of each is outlined below.

Vocabulary:

Cinema: A 16 mm sound film projected without interruption in a totally darkened classroom is hereafter referred to as "cinema".

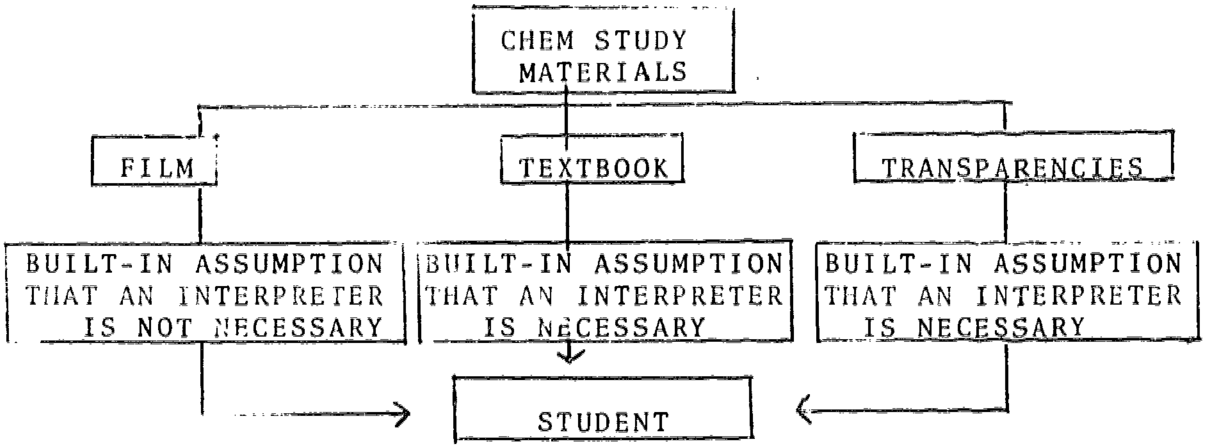
Team-teaching: A 16 mm sound film projected in a semi-darkened classroom and periodically stopped by the teacher on "still" that is with continuation of the projection of a still image in order that discussion, explanation, student comments etc., and the taking of notes be made possible is referred to from now on as Team -teaching with a 16 mm sound film.

Marsh in his history of PSSC complains that of the 2100 teachers who participated in PSSC institutes up to 1961 conceded they had learned science, less than half of them had in fact adopted the new materials (Marsh, 1964, pp 249-263).

Teachers as professionals, and districts as autonomous governments, must be free to pick and choose the supplies they teach with and purchase. The task of any particular program is to sell the teachers on the use of the materials. How can we best sell the use of CHEM Study films? As cinema they are of little value and are prone to "erosion". The teacher has so much ground to cover that he just has no time to show films.

Our work has led us to believe that the way to sell the teacher on the use of films is to get him involved, not displaced, by the film. The film must Team-teach with him, the matter to be covered.

It is therefore desirable to assume that the film is in need of interpretation by the teacher just as much as the textbook or the transparencies making up the CHEM Study materials are in need of interpretation contrary to what is suggested by the following paradigm.



Film Utilization

<u>Student</u>

Student Notes

1. Purposes
   - -information to be acquired
   - -initiation to knowledge to be acquired
2. Partially filled notes
   - -diagrams
   - -tables of data
   - -graphs
   - -statements
   - -definitions
3. Objective test

<u>Teacher</u>

Teacher's Guide

1 - summary
2 - purposes
3 - what to do during showing
4 - film outline
5 - film sound track matched to completed student's notes
6 - what to do after showing, class discussions, etc.
7 - review of purposes
8 - supplementary material
9 - bibliography

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Enseignement Individualise De La Chimie Par L'Audio-Tutorat

Marie-Reine Gervais
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Presented (in French) to the Symposium on the Systems Approach to College Chemistry Teaching, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 7, 1973

Nous avons été amenés à penser a un enseignement individualisé de la chimie par l'audio-tutorat en voyant le succès remporté par cette méthode appliquée en biologie par M. Postlethwait à l'université Purdue et aussi, en étant témoin des excellents résultats obtenus par le département de biologie du CEGEP où j'enseigne actuellement.

Ce qui nous a attiré aussi vers cette méthode ce sont les avantages qu'elle procure aux étudiants. Dans cette méthode, l'étudiant devient l'agent premier de sa formation et il a aussi l'avantage de pouvoir suivre son rythme personnel en mettant le temps qu'il juge nécessaire à l'étude d'une question. Il peut même revenir en arrière au besoin ou même accélérer le rythme. De plus, l'étudiant peut choisir parmi l'ensemble des moyens mis à sa disposition pour cerner une question, celui qui convient le mieux à son mode d'apprentissage: ceci peut aller du film au texte écrit. De plus, la liste d'objectifs de comportement très précis et très détaillés que l'étudiant recoit chaque semaine lui permet de savoir exactement où il va. Ces objectifs constituent le minimum de ce qu'il doit acquérir pour qu'on lui reconnaisse une compétence en ce domaine. Il pourra s'auto-évaluer en fonction de ces objectifs et déterminer par lui-même s'il doit ou non recommencer telle ou telle partie et aussi s'il est prêt à se faire évaluer.

Par suite, à l'hiver 1972 nos efforts se sont portés sur les cours de chimie 202 et 201, soit un cours de chimie organique et un cours de chimie générale, puis le travail a été amorcé en chimie 101 en hiver 1973 et sera poursuivi à l'automne 1973. Durant l'été 1973, le travail débutera en chimie 901 et 302.

Voici comment nous comptons appliquer cette méthode en chimie organique 202 en automne 1973. Nous allons procéder en trois étapes: la première étape sera une assemblée générale, la deuxième, le travail individuel et la troisième, l'évaluation.

ASSEMBLÉE GÉNÉRALE

Tput d'abord, il y aura une assemblee generale au début de la session au cours de laquelle le professeur responsable et les étudiants feront connaissance. La méthode sera alors exposée et c'est a cette personne que les étudiants devront recourir s'ils ont des difficultes main ce qui est important ćest qu'ils le voient surtout comme un guide dans leur travail. Lors de cette première assemblée, le professeur exposera les grandes orientations du cours. Ces assemblées se répèterone selon les besoins au cours de la session, par exemple pour faire les liens entre les différentes parties de la matière ou pour faire un exposé magistral sur des parties plus difficiles ou encore, si les étudiants en manifestent le désir.

TRAVAIL INDIVIDUEL

Ensuite, le travail de l'étudiant s'effectuera surtout en cabine dans le centre d'études et au laboratoire qui lui est contigu. L'étudiant recevra au début de l'année un cahier de travail constitué de 15 mini-cours. Chaque mini-cours contient des schémas, des tableaux à remplir, des exercices, des travaux pratiqqes et aussi des objectifs de comportement que nous avons établis avec l'aide d'un docimologue. L'étudiant sera guidé dans son travail étape par étape par un document audio-viauel dont j'ai préparé le scénario et dont la production a été faite par l'équipe audio'visuelle du collège.

Le document audio-visuel mis à la disposition de l'étudiant dans sa cabine a pour but de l'aider à atteindre les objectifs fixés. Ce document contient entre autre les manipulations que l'étudiant aura à effectuer au laboratoire. A titre d'exemple, j'ai apporté aujourd'hui avec moi un document audio-visuel portant sur une expérience de laboratoire qui l'étudiant n'a pas le temps de faire au complet mais dont il peut voir le déroulement quand même et poursuivre à une étape que nous avons déterminée.

Regardons maintenant ce document audio-visuel qui est en fait une copie de travail, de toute facon, je suis accompagnée du responsable de la production qui pourra vous renseigner sur les questions techniques qui pourront vous venir à l'esprit. J'ai aussi apporté avec moi l'appareil que l'étudiant utilisera dans sa cabine.

Le document audio-visuel ne contient que le strict minimum de théorie nécessaire pour comprendre le travail qu'il fait. Ce travail en cabine et au laboratoire sera d'une durée minimale de 3 heures par semaine. C'est là dans sa cabine que l'étudiant peut facilement fonctionner au rythme qui lui convient.

EVALUATION

La troisidme étape est l'évaluation que nous voulons mettre au point au cours de cet été. Nous avons l'intention de faire des tests régulièrement, à tous les 2 mini-cours, par exemple. Cette évaluation pourra se faire en partie oralement en réunissant des petits groupes de 7 étudiants ou en réunissant un grand groupe d'étudiants qui seront amenés à subir alors des tests scientifiquement structurés à l'aide d'un docimologue. De toute facon, les tests seront préparés afin de vérifier si les objectifs ont été atteints.

Disons, pour clore cet exposé, que la mini-experimentation que j'ai tentée des 15 mini-cours de chimie organique laisse présager que cette méthode a toutes les chances possibles de réussite.

Self-Instructional Packages as Supplements for General Chemistry

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Presented at the Symposium on Modules for College Chemistry, 33rd Two-Year College Chemistry Conference, Dallas, Texas, April 6, 1973.

To clarify the purposes of the self-instructional packages that I will describe, I will briefly outline the background that led to their development.

I joined the faculty of the Northeast Campus of Tarrant County Junior College when the campus first began operation five years ago. After some fifteen years of teaching undergraduate chemistry (in five different colleges), I encountered an administration that was willing to devote more than lip-service to the improvement of instruction. The district provides a competent media staff, adequate media equipment, and encourages and supports faculty efforts to experiment and innovate in the search for more effective instructional materials and techniques.

I have always deplored the poor grades and high attrition rate in my classes, and have worked through the years to find better ways of helping students to learn chemistry. I supplement lectures with models, printed "hand-outs", films, overhead transparencies, demonstrations, etc., whenever and wherever I feel that they will be of value to students.

With the opportunity and the encouragement to utilize media extensively as a tool to improve instruction, I decided what I could do, within the limitations of my abilities, time, and past experience, that would be most likely to prove helpful to my students.

My first inclination was to put the entire freshman course into a self-paced, A-T format. After studying programs using that approach (chemistry and other subjects), I reached several conclusions. The sheer volume of work involved in developing all the necessary soft-ware was beyond anything I could do within a reasonable time, while teaching a full load and helping equip and start up the physical science department of a new college. Secondly, I was not fully convinced that a totally self-instructional, A-T approach was any better than what I was already doing. From observing a few programs where such an approach was in operation, and vastly improved learning was claimed, I found that innovative grading procedures were also being used which made it difficult for me to be sure that the improvement in student performance was real and a result of the mode of instruction rather than apparent as result of the mode of grading. Finally, I enjoy lecture and the classroom interaction with students, and I know from experience that many students learn very efficiently from well-prepared and well-presented lectures. Therefore, I was reluctant to discard lecture altogether for a system of instruction that I still had some reservations about.

Most of my doubts concerning the effectiveness of a totally self-instructional, self-paced, A-T instructional program have long since been laid to rest. Such an approach has several decided advantages, and if the material is well-prepared and well-presented, I see no reason why it would not be successful. It is my belief that there is no one instructional system that is superior to all others, despite the pronouncements of some educational theorists. Because of the varying learning styles of students, providing a variety of learning approaches is superior to any single approach. Also, I believe that each instructor can be most effective when he utilizes these instructional strategies that best suit his abilities, interests, and particular situation.

I decided that the most helpful (and most likely to be successful) thing that I could do for the student would be to provide additional avenues for learning; built around the lecture which I have spent years in planning, organizing, and developing techniques of presenting. I have said all the foregoing so that you would not be too disappointed by the very simple self-instructional packages which I have prepared as supplemental study material for my students. Although these packages have not revolutionized the teaching of chemistry, and although all of my students do not now make A's (in fact I still have dropouts and failures), they do have some advantages and have been helpful to my students. They provide the student with another avenue for learning that is in addition to lecture, lab, textbook, etc.

The material presented in the packages and order of presentation, closely parallels the lecture. The most important facts and principles of each major topic are presented in a series of self-instructional packages. Each package consists of:

1. Pre-test - which is usually 10 questions covering the material presented in the package. If a student answers all questions correctly he may skip the package.

2. Booklet - which consists of: (a) a statement of the objectives of the unit, in behavioral terms, (b) printed material (using large type) and illustrations similar to that which is presented in lecture via the chalkboard, transparencies, etc., and (c) practice tests which follow each small segment of material. After the questions or problems of the practice test have been answered (on the answer sheet which is provided) the student turns to the next page where the answers (or solutions to problems) to the practice test are given..

3. Answer sheet for practice tests in booklet.

4. Audio tape - cassette tape which explains, discusses, etc. material in booklet in manner similar to classroom presentation.

5. Post-test - which is similar to pre-test. If the student misses any questions he is urged to repeat all or part of the unit until it is mastered.

6. Evaluation form - each student evaluates the package, providing information that is useful in revising them.

7. Special charts - Periodic, atomic volumes, electronegativities, etc., and tables, such as logs, etc., are added to packages as appropriate.

At the first class meeting each student is given a list of the packages and the way they are to be used is explained. They may be checked out at the reserve desk in the library for study in the carrels provided there or in the laboratory for study in a satallite media room there. Also, they may be checked out for for overnight or weekend use in a manner analogous to a book on reserve.

To provide information of value in evaluating and improving each package, the student is asked to mark any errors made on the pre-test and post-test (a comparison of the number of errors gives an indication of the effectiveness of the unit) and on each practice test (pin-points areas in greatest need of improvement), and finally to complete an evaluation form. All these are turned in, unsigned with the packages.

Some of the advantages of the packages are:

1. Student can study at the time most convenient to him.

2. Each student can study each package at town rate, repeating all or part as many times as necessary.

3. Practice tests provide for frequent and immediate checks on comprehension and helps to reinforce learning.

4. Questions on pre-test and practice tests introduce the student to the objectives in the form of test questions which require behavior similar to the tests which will be given for grades.

5. Provide a convenient means of drilling students on material the instructor considers most important.

6. Extremely helpful to students who miss lecture.

An accurate assessment of the success or lack of success of the packages is not possible at this time. Their success from the stand point of student response is unquestioned. Although they are not required and no record is kept as to who uses them, approximately 80% of the students do use them. This is based on the numbers of tests and answer sheets turned in for each unit. Also, the evaluation forms and individual student comments indicate strong student approval.

The following comparison of grades, from one course which

I have taught for the last three years, indicates some improvement in grades which may be attributed, at least in part, to the packages:

Fall 1970			Fall 1971			Fall 1972		
Grade	# Students	%	Grade	# Students	%	Grade	# Students	%
A	5	10	A	11	13.5	A	13	13.8
B	6	12	B	25	30.8	B	27	28.7
C	23	46	C	29	35.8	C	37	39.3
D	5	10	D	7	8.6	D	7	7.4
W&F	11	22	W&F	9	9.9	W&F	10	10.6
Total = 50			Total = 81			Total =94		

Some comments concerning factors that limit the inferences that can be drawn from the above are in order.

1. These grades are from a one-semester course called "Essentials of General and Biological Chemistry" which is designed for students in health occupations programs. Therefore, all packages are not used for this course. Also, admission to these programs is fairly selective and the students are more highly motivated, than the average. These classes are used because my teaching assignment has varied, making this the only course where a meaningful comparison of grades could be made over the past three fall semesters.

2. The number of packages available has increased each year since 1970.

3. New health occupation programs have been added since 1970. In general, the admission to these newer programs is less selective than the dental hygiene program from which most 1970 students were drawn.

For the benefit of those who may have administrative responsibility and would like suggestions concerning ways to encourage faculty in instructional improvement, I would like to list some of the things which TCJC N.E. administration has done that has proven to be very beneficial.

1. Provide funds for adequate media equipment and staff.

2. Provide funds to allow a limited number of faculty to undertake significant instructional development projects. These projects fall into three categories based somewhat on magnitude: (a) Acyclic projects - funds to provide for modest remuneration to faculty members for work on special projects during Christmas holidays, etc. Also, provide funds for materials, typing, etc. Generally short-term projects. (b) Summer projects - remuneration, materials, etc., for work during summer vacation on larger projects. (c) Released time - reduction in teaching load to allow for development of special projects.

3. Provide workshops devoted to principles and practice of a variety of innovative approaches to instruction. Some workshops were available locally, others out of town.

4. Provide travel funds to visit other institutions to observe innovative programs, to attend conferences, etc.

5. Brought in consultants to talk on special topics, conduct workshops, etc.

6. Last, but probably most important, the administration has encouraged faculty involvement in the following ways, in addition to the above: (a) verbal encouragement to all faculty members and recognition and support for those who do undertake worthwhile projects, (b) while encouragement is positive there is no attitude of innovate or else. That is, those with interest and initiative are encouraged and supported, but those who do not have the inclination (or ideas) to try new instructional approaches are not made to feel they have to do something different anyway. (c) There is no penalty for failure. The administration has assured the faculty that it recognizes that all innovative efforts to improve instruction will not be successful. The philosophy seems to be that it is better to have tried and failed than not to have tried at all. (d) Distinct policy relative to ownership of instrucor developed instructional materials that prove to have commercial value is very fair to the instructor.

A Report on Individualizing Chemistry Instruction for Mastery Learning

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Presented to the Use of Programmed Material and Individualized Instruction Timely Topic Forum at the 30th Two Year College Chemistry Conference, Corvallis, Oregon, June 17, 1972

The problems which this project on individualizing instruction were addressed included the following:

1. Varying degrees of student preparedness in mathematics and chemistry.
2. Varying rates of student learning due to other class pressures, outside pressures, and personal variations.
3. When a student gets behind, he seldom catches up.
4. Too many students are not successful, too many students "slip through". At the end of the year many do not know fundamentals.
5. Many students do not understand the material with one explanation, i.e. foreign students.
6. No trailer course exists in the spring.
7. Conflicts in student schedules occur with only one section of general chemistry offered.

The procedures adapted for this project included the following:

1. Tape the actual lectures and use an overhead projector then use the transparency to produce a ditto master and then make lecture notes.

2. Tapes and notes are available within an hour at the library and in the instructor's office. This technique generates a need for a learning resource center.

3. Frequent testing - (13, 1st. qtr., 8, 2nd qtr., 6, 3rd qtr.) when the student decides he is ready.

4. The test is graded within 24 hours (usually) and the student proceeds or repeats. A note is written and posted telling weaknesses.

5. Tests are available from the department secretary and in the instructor's office. (Not much security).

6. Programmed text is used.

Results of the Project:

A small number completed the entire sequence. Of 48 students who originally started in the fall, only three completed the 203 course by the end of spring term. It is very important to note that 27 of the 48 completed only the first chapter and took four or fewer tests. Thirteen completed 201; 7 of those 13 completed 202; and 3 who completed the 203 sequence. In January there were 9 students who began the 201 course. This was the first trailer course we had been able to offer at COCC. Of these 9, six again did not complete over four exams. Two students got over half-way through with the 201 course, and one student who began in January completed the entire sequence of three quarters work in 2 quarters time. There were 3 students who enrolled in 201 spring quarter. None completed the course. The results of giving the students responsibility appears to be a failure with a large percent of our students. Without constant prodding the extent of dropout appears to increase tremendously.

On the positive side, the results obtained by those students who did complete either a course or two, or the entire sequence, appear to be exceptional. The same final exam was given that had been given to a previous class for the 201. The results of the 13 students who completed the 201 was an average of 148, compared to 102 in the previous class of 27 students. There is a selection process having taken place in which the 13 students who completed 201 may represent the 13 best students. There are probably some other students who have not yet completed 201, who will score relatively high on the final exam. To eliminate any possibility of just the top scores being recorded, the 13 top scores from the previous course were averaged, giving of 135, as compared to this year's 148. In addition there were four students this year who scores above 80% compared to none in the previous year. There were eight students this year who scored above 60% as compared to only three in the previous year. It appears that improved learning has taken place among those students who have put out sufficient effort to complete even one course. The previous year there were 14 students who completed the entire sequence, and received a grade. One of these did receive an F. The 14 took an American Chemical Society Cooperative examination in general chemistry and averaged the 62nd percentile, with the top score being at the 90th percentile. This year there were four students who completed the course and took the examination. Three of the four scored at the 90th percentile or above, with the low score of the four being the 75th percentile.

One of the students who completed the entire sequence did not begin until January. His success is indicated by his score on the exam at the 92nd percentile. The student received all of the lectures via the tapes and lecture notes, with the exception of two review sessions which he attended the last week of school. There was no lack of individual contact.

Summary and Conclusions

The technique allowed variable rates of learning from whatever source and reason. Some students were able to ease off chemistry when other pressures were too great and then pick up the slack. Others eased off and never picked up the slack. Students did show the ability to recover to some extent, after getting behind. One student did very little work first quarter because of his work load, however he did complete two quarters of work through the year. It appears that no student has slipped through without a thorough knowledge of the fundamentals of chemistry. Many students including foreign students, commented on the advantages of being able to rerun the tape to better understand some particular part; rewind and relisten. Not one of the six foreign students completed more than four exams.

The conflict of schedules was worked out with two of the three students who completed the entire sequence, by allowing them to miss the lectures in at least one quarter. We are now able to offer Chem 201, 202, and 203, each of the three quarters as well as during summer school. This has given the students a great deal more flexibility and has allowed students to begin in January.

The great failure has been in the low number of students who have been able to successfully complete the program. Other more subtle weaknesses is the large amount of time involved with 27 exams through the year, in addition to the 73 lectures. Another disadvantage is the amount of time required of the instructor. It is necessary, when individualizing a course, to have an instructor available for the individuals. In addition, the large number of tests that are taken and the inefficient method of grading one or two tests of a kind increases the work load. The additional disadvantage is that the administration tends to view the work load as being decreased once the program is prepared. As an example, next September I will be offering 201, 202, and 203. The plans are to begin an organic course which will be a three hour lecture course in the fall. Our department chairman has determined that with that small a load, I could also teach Math 11 because I won't be lecturing to the 201, 202, and 203. Probably the only ultimate answer would be to have an administrator teach the course in this manner.

The cost of conversion is quite minimal from the equipment and material point of view. I received a $200 grant and probably spent for supplies another $100. This included the purchase of three cassette recorders of the $30 to $35 range, which have automatic level control, built-in AC capabilities, and appear to be extremely rugged. The only other costs were the sixty minute cassette blanks which were purchased at a local discount store at 42¢ each and the reproduction of the notes.

Recommendations for Modifications for Next Year

Next year there will be a deadline for each of the first four tests with the assumption that if a student commits the time to complete the first chapter, and take the test for it, he will more likely continue on his own when he is turned loose. Rather than having three scheduled lectures per week, each class will have one discussion time at which the main thrust will come from the students. Each student will also be given a schedule showing where he should be at any particular time if he anticipates completing the year's sequence in three quarters time. Further refinements could be multiple forms of each test and multiple-choice questions so that the test could be machine graded.

Chemistry for the Allied Health Students

Trends in Paramedical Chemistry

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Presented to the Symposium on Chemistry for Allied Health Students, the Thirty-Third Two Year College Chemistry Conference, Dallas, Texas, April 6, 1973.

Paramedical programs in two-year colleges include the following:

Certified Laboratory Assistant
Inhalation Therapy Technician
Medical Assistant
Medical Laboratory Technician
Nursing
Occupational Therapy Assistant
Physician's Clinical Assistant
Surgical Assistant

Most of these require some exposure to chemistry. Recent symposia lead one to believe that the chemistry taught in these programs is integrated with other disciplines, e.g. anatomy and physiology, and that it is taught in departments other than chemistry. A survey of catalogs* of fifty community colleges indicates chemistry departments teach paramedical chemistry.

	No.	%
Taught in chemistry	37	74
in biology	5	10
in physical science	2	4
No chemistry required	6	12
TOTAL	50	

The courses in the thirty-seven colleges in which the paramedical chemistry is taught by the chemistry department was further investigated. The length of the course varies as follows:

44

	No.	%
One quarter	4	11
One semester	9	24
Two quarters	2	5
One year	20	54
Three semesters	2	5
TOTAL	37	

Usually there are no prerequisites for the class. Some require high school chemistry, others algebra:

*Chosen at random by department secretary. Those selected had community college or junior college on cover.

	No.	%
No prerequisite	20	54
High school chemistry	7	19
One year of algebra	7	19
High school chemistry and algebra	1	3
High school chemistry and two yrs. algebra	2	5
TOTAL	37	

A subcommittee, Chemistry for Allied Health, has been meeting at every $2YC_3$ since March, 1971. They have been concerned mainly with the question, "What shall we include in paramedical chemistry?".

The Los Angeles meeting in April, 1971, was concerned with inorganic chemistry only. A list of topics generally given in paramedical chemistry texts was studied. Time allotments are listed in Table I.

TABLE I

INORGANIC CHEMISTRY

	Quarter	Semester	Year
Total Time	3-4 wks	5-6 wks	15-16 wks
Measurement	1½-3 hrs	5 hrs	2 wks
Atoms, Molecules, & Periodic Charts	8 hrs	2-4 wks	2½ wks
Solutions	4-5 hrs	6-8 hrs	3 wks
Equations	2 hrs	2 hrs, 2wk	1½ wks
Stoichiometry	-	3 lec	1½ wks
Gases	1 lab		
Radioactivity	1 wk		

Generally one-third of the paramedical chemistry offering is devoted to general chemistry. The metric system and temperature conversions are studied. Orbital configurations are deleted in one-quarter and one-semester classes. The study of solutions includes per cent and molar concentrations but does not cover molal and normal solutions. There is no time for redox reactions or stoichiometry problems and gas laws are given only a brief survey.

The same kind of study was done at the subcommittee meeting in Boston, in April, 1972, with organic chemistry. A list of topics from two texts was examined. Time allotments are listed in Table II.

TABLE II

ORGANIC CHEMISTRY

	QUARTER	SEMESTER	YEAR
Molecular Structure	½ hr.	3 hrs.	1 hr.
Hydrocarbons	3½ hrs.	9 hrs.	7 wks.
Alkyl halides	½ hr.	1 hr.	2 wks.
Alcohols, Phenols, Ethers	1 hr.	2½ hrs.	2 wks.
Aldehydes & Ketones	2 hrs.	3½ hrs.	2 wks.
Acids, Esters	1 hr.	2½ hrs.	2 wks.
Amines	--	1½ hrs.	1 wk.

Structure, nomenclature, and medical use of organic compounds are emphasized in the courses. Some reactions are considered, e.g. substitution, addition, hydrogenation, esterification, but many are not even mentioned, e.g. Grignard reaction, and there is not time for discussion of mechanisms of reactions.

Biochemistry was the discussion topic for the subcommittee in New York, August, 1972. Rather than go through the tedious procedure of examining a list of topics and trying to recall exactly how much time was spent on each, the lists were taken home by committee participants and mailed. Again, time allotments are shown in Table III.

TABLE III

BIOCHEMISTRY

	QUARTER	SEMESTER
Total Time	5-8 wks.	2-7 wks.
Carbohydrates	3½-9 hrs.	2-5½ hrs.
Lipids	1-7½ hrs.	1-4 hrs.
Proteins	2-12 hrs.	1-4½ hrs.
Nucleic Acids	0-2 hrs.	0-1½ hrs.
High Energy Compounds	0-10 hrs.	0-2 hrs.
Enzymes	0-6 hrs.	0-2 hrs.
Metabolism	0-7½ hrs.	0-10 hrs.
Body Fluids	0-2 hrs.	0-1 hr.
Drugs	0-4 hrs.	0-1½ hrs.

Coverage of biochemistry is generally limited to carbohydrates, fats, and proteins.

What chemistry teachers offer and what paramedical programs directors want are not necessarily the same. The directors of twelve programs at Cuyahoga Community College and Cleveland State University examined the list of questions given in the Inorganic-Organic-Biological Chemistry Test for Paramedical Chemistry (ACS examination, Form 1971), to decide whether or not each of the topics was important to his program. The topics selected by 75% or more are given in Table IV.

TABLE IV

Topic	Number stating that this is important in program	Per cent
	INORGANIC	
Body temperature	16	100
Dialysis	15	94
Atomic structure (no. of electrons)	14	88
Solubility (gas in liquid)	14	88
Buffers	14, 12 (2 questions)	88 75
pH and molarity	14	88
Osmotic pressure	14, 12	88 75
Temperature & energy	14	88
Catalyst	14	88
Oxygen in anesthesia	14	88
Calories	13	81
Atomic number	13	81
Per cent concentration	13	81
Use of soap	13	81
Physical changes	13	81
Conductivity of solutions	13	81
Weak acids	13	81
Energy & motion	13	81
Mixtures and compounds	12	75
Metric conversions (weight)	12	75
	ORGANIC	
Ethers	13, 7, 7 (3 questions)	81
Hydrogen bonding	12, 9, 7	75
Amines, basicity	12	75

TABLE IV (con'd.)

BIOCHEMISTRY

Glycogenesis	16	100
Digestion, peptide bonds	16, 15	100
Digestive enzymes	16, 15, 15, 13	100
Blood plasma, blood serum	16, 16	100
Denaturation of protein	15, 14	94
Carbohydrate metabolism	15, 15	94
Glycolysis	15	94
Caloric value of fats	15	94
Plasma proteins, edema	15	94
Protein metabolism	15, 9	94
Isotonic solutions	15	94
ATP-ADP	15, 14	94
Vitamins	15, 14, 13, 7	94
Hormones	15, 15, 10	94
Inorganic salts in metabolism	15	94
Cell membrane permeability	15	94
pH and enzymes	14	88
Carbohydrates	14, 12, 10	88
Protein structure	14	88
Protein, isoelectric point	14	88
Proteins as buffers	14	88
Iodine number	14	88
Bases in DNA	14, 13	88
Radiation and DNA	14	88
Lipid absorption	14	88
Chemistry of nerve impulses	14	88
RNA	14	88
Respiratory chain (hydrogen transport system)	14	88
Carbohydrates, digestion	13	81
Hemoglobin	13	81
Fat metabolism	13, 12, 11	81
Chloride shift	12	75
Fatty acids	12, 9	75

Note that about one-third of the inorganic topics were considered important and only two of the topics in the organic list were selected by 75% of the group. In contrast, most of the questions under biochemistry were chosen.

The dilemma of the chemistry instructor is like that of a foreign language teacher having to teach a course such as French for the Traveler. He must delete most of what he considers basic to the study and include only what is needed for the student to get by.

Biochemistry is the vocabulary that the paramedical needs.

Chemistry for the Allied Health Students at Santa Barbara City College

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Presented to the Symposium on Chemistry for Allied Health Students, Thirty-Third Two Year College Chemistry Conference, Dallas, Texas, April 6, 1973.

Santa Barbara City College is a community college with an enrollment equivalent to approximately 5000 full-time students. Like most community colleges in California its curriculum includes vocational as well as transfer programs, and its allied health programs are quite similar to those found in other two-year colleges. The place of chemistry in the allied health programs at City College is shown in Table I.

Table I		
Present Programs	Length of Program	Chemistry Required
Registered Nursing (ADN)	4 semesters	Required
Vocational Nursing	3 semesters	
Dental Assisting	4 semesters	
Medical Assisting	4 semesters	
Radiological Technologist	4 semesters + internship	Recommended
Proposed Programs		
Inhalation Therapy	4 semesters	Required

The chemistry course that is required of an RN candidate must be completed before the student is accepted into the program.

It is interesting to note that the number of associate degree nursing programs is increasing, while the number of nursing schools and hospital schools is decreasing, and that approximately one-third of the nursing students are in two-year programs (Table II).

Table II			
Trends in Registered Nursing Programs and Enrollments			
	Oct. 1971	Oct. 1972	Enrollment 1972
Baccalaureate	285	293 (19)*	73,890
Associate Degree	491	541 (55)	67,543
Diploma	587	543 (9)	71,694
Number of programs	1363	1377 (83)	213,127

*Figures in parentheses are for California

If the ADN programs in community colleges continue to grow at the rate suggested by these figures, it is likely that the majority of student nurses will one day be enrolled in two-year programs. For this reason it would be a good idea to examine the place of chemistry in a typical ADN curriculum.

A number of ADN programs have no chemistry requirement, but these programs are in the minority. Many schools include chemistry as part of the curriculum, while in others it is a prerequisite for admission to the program. In most cases the chemistry requirement is satisfied by a short course -- often no more than one quarter in length. Many schools either do not see the need for, or do not have the resources to offer a chemistry course designed for students in the allied health areas, with the result that these students often derive little profit, and less pleasure, from their chemistry experience.

One semester of chemistry is a prerequisite for admission to the ADN program at City College. Until 1970 the chemistry department offered two introductory courses: a one-year course for science majors, and a rigorous one-semester course with an emphasis on problem solving. During the 5 years prior to 1970 I had become acutely aware that neither of these courses was providing the nursing candidates with the background that they would need for physiology and microbiology. By agreeing that I would design the course so that it would be suitable for students besides those in the allied health areas, I was permitted to offer a third alternative -- a course in which chemical theory provides the background for understanding many biological phenomena.

The major problem I encountered in preparing for this course was the lack of a suitable textbook and relevant laboratory exercises. The available books were either too long, too difficult, or lacking in appropriate examples and applications. For this reason I have written "Chemical Principles and Their Biological Implications," which will be published in January, 1974, by Hamilton Publishing Company Division of John Wiley. In writing this book I tried to take into account the shift in programs from traditional diploma schools to the community colleges and to aim for a final product that would be appropriate for the shorter courses that are generally associated with ADN programs.

Since the course and the book are so closely related, in describing the course I shall be describing the book as well. The traditional separations between inorganic, organic, and biological chemistry have been largely ignored. I have attempted to integrate organic and biochemistry wherever they are appropriate -- for example, organic compounds are discussed along with the inorganic compounds in the section on chemical bonding, and again in the section on properties. I have made selective omissions of material that I felt was less important than other concepts; thus there is little, if any, discussion of reaction mechanisms, equilibrium and solubility product constants, classical thermodynamics (although entropy and energy relationships are covered in detail), and electrochemistry. The emphasis is on application of theory rather than problem solving. Stoichiometry and gas law calculations are included, but they are not stressed. Perhaps the most effective way of explaining the primary thrust of the course is by selecting two representative topics and showing the way in which these topics are approached.

The introduction to this type of course typically includes a discussion on measurements and physical properties and states of matter. My approach is to show that an investigation of the properties of matter is superficial unless we incorporate measurements in more fully describing these properties. In the discussion of physical states of matter, I point out the use of liquid crystals in locating inflammation and blockage of circulation, and the relationship between the heat of vaporization of water and the use of steam for sterilization. Cryogenic applications include the preservation of tissues, organs, and fluids in "banks", and the surgical techniques employing liquid nitrogen. The calorimeter description includes a little follow up on exactly what calories mean in terms of energy value, how the calorimeter is used to determine the energy value of foods, and the significance of it. We talk about the specific heat of substances. It is a perfect place where you can bring in the idea that the specific heat of water is a very important factor in controlling the body temperature because of the tremendous heat that is required to raise the temperature of a being, which is primarily water, so you can stand out in the sun all day and soak up these calories and the temperature doesn't go up too much. You have a cooling mechanism which also depends on heat of vaporization which happens to be very high so we can also talk about the heat of vaporization controlling the body temperature.

Specific gravity determinations are brought in when you talk about urine and other fluids in the body. Pressure measurements are related to blook pressure and its significance. This is how measurements are introduced to the students. I believe that there should be a reason for everything that we do in this course and a follow up to it.

Almost all books have a chapter on water and solution chemistry. In solutions it is not just aqueous; there are tinctures and elixirs. When we talk about temperature effects on solubility is a beautiful time to introduce the problem of transporting a non polar gas in an essentially polar medium and the problem of low solubility of oxygen in water and the effect of temperature on solubility and when the blood flows through the lungs and gets cooled then it has a slightly higher affinity for the oxygen that is dissolved partially. When we talk about concentrations, tie the concentration to something. Milligram per cent is very easy to introduce and tie it to blood glucose or other electrolyte concentrations in the blood stream. Parts per million is easy illustrated with the example of chlorination of swimming pools or drinking water supplies. Parts per million is typically used when talking about water pollutants or air pollutants. Percentage by weight and by volume is used in making up saline solutions and so on. This doesn't mean that I eliminate molarity, but these are more close to home type things. The preparation of dilutions is related to the dilution of germicides and chemicals for injections. Colloids are tied to the cell as a colloidal dispersion. In the properties of water are included reactivity with metals, oxides of metals and nonmetals. Also include the hydrolytic properties of water on biological molecules paving the way for the introduction of digestion at a later stage. In connection with hydration we bring in the examples of the hardening of Plaster of Paris and the use of desiccators for drying chemicals. Colligative properties opens the whole thing up. Here we talk about osmosis, dialysis, vapor pressure, and the autoclave using high temperature steam for sterilization. In this area on membranes it is really fun: the permeability of ions and selected molecules; the chemical model of a membrane; the osmotic pressure relationships; the production of edema as a result of osmotic pressure differences; hemodialysis; the explanation of the artificial kidney machine; low sodium foods prepared by dialysis; the use of reverse osmosis; and membranes for the desalting of water for water supplies. The drowning of a person in fresh water occuring when water enters the lungs, enters the blood stream by osmosis, causes hemolysis of the red blood cells and liberates potassium ion which causes ventricular fibrulation so that the person recovers from drowning and dies of a heart attack. The physiological functions of water are lubrication, transportation, purification, temperature regulation, and hydrolysis of molecules. The reuse, and reclamation of water to make it potable ties the whole thing together.

In conclusion, the course should meet the needs of the students and it should not follow traditional lines or be just abstract chemical theory. I have attempted to give the theory relevance and show the importance of chemistry in the allied health areas in my book. I welcome your comments and suggestions after you have examined it.

Chemistry for the Allied Health Students at Staten Island Community College

Seymour Stambler
Staten Island Community College

Presented to the Symposium on the Chemistry for Allied Health Students, Thirty-Third Two Year College Chemistry Conference, Dallas, Texas, April 6, 1973.

Staten Island Community College has an enrollment of 5400 day and 3200 evening students. It is a fully accredited co-educational institution and is a unit of the City University of New York. The school is sponsored and administered by the Board of Higher Education, the governing body of New York City's municipal college system, under the program of the State University of New York. Under this program, the state provides one third of the operating budget of the college and half of the capital budget, the balance being provided by the city of New York and by nominal student fees.

The college offers 2 year transfer programs leading to the AA and AS degrees and 2 year career programs leading to the degree of AAS.

As part of the City University we participate in the CUNY OPEN ADMISSIONS POLICY. This policy opens admission to the University for all who have graduated from a New York City High School after June 1970. Mere admission is not enough - the university makes every effort to provide the remedial and supportive components to prevent the open door from becoming a revolving door. When this policy was initiated, the university was also mandated to preserve and enhance its academic quality. The colleges were charged with the additional requirement to develop new paths of lateral access. The colleges were mandated to adapt to the needs of students rather than compelling students to conform to rigid institutional patterns.

From the brief overview of Open Admissions, two things may have become evident. The first is that the policy was not devised so that students would be admitted in September and sent home the following January or June. Secondly, open admissions is not a means of diluting educational programs. The content of the courses should also continue to include what a quality faculty considers necessary to be included. This, according to the guidelines, might require restructuring and redesigning curriculum.

Reactant A is the policy mandated to the faculty. In chemistry we are still dedicated to teaching subject matter. Therefore, we had to take a closer look at the student to help us attain our mandate. Let us look at reactant B, the student.

Our average student is the first in his family to attend college. More than 45% of the fathers and 44% of the mothers did not complete their high school education. Our student does not receive any assistance from home; for many of them this includes financial aid. As a result over 50% of our students have to work to help pay for their education. Coupled with this time consuming obligation, (44% work more than 30 hours per week), is the problem that 55% of our students cannot make optimum use of their time because of poor study techniques.

The students' lack of basic skills in reading and mathematics make learning chemistry difficult. Their failings in these basic skills have hindered them throughout their academic career.

Thirty-six percent of the students have difficulty in concept formation, another prime requisite for achievement in chemistry and somewhere along the line, they have developed a dislike or distaste for, or a fear of chemistry and they are not sure that they want or need the course. Sixty-five percent of our entering students are not certain of their choice of a career; they desire aid in planning a vocation. When these students are confronted with what is to them a relatively difficult course, they decide that chemistry is not their cup of tea. To me, this is apparent in a study of the grade distribution in a chemistry course offered in a year before open admission (Fall 1968) and the distribution in the same course scheduled during Open Admission (Spring 1972).

	Percentage of:					Registrar's Grade		Temporary
	A	B	C	D	F	H. 44	J/K	Grades L(MN)P
After OA	9	13	17	8	7	12	32 22	2
Before OA	8	17	26	16	8	3	19	5

The grade distribution in the A B & F grades was not that different. However, the C & D grades and the registrar's grades do differ considerably. Before Open Admissions, the percentages of C & D grades were 26 and 16 respectively. After Open Admissions these were reduced to 17 & 8 per cent. At first glance this might be taken to mean that the OA students received better grades. However, it means that the poorer students in the class dropped the course and the better students of this group remained to receive the C & D grade. The number of students receiving registrar's grades H, J, K, etc. doubled after OA.

Thus we see from this data and data available from other courses that the student prior to Open Admissions was more motivated, more interested and willing to learn and more willing to work to learn. Since the student no longer furnishes the drive, the burden of stimulating the student's interest and making him more willing to work falls on the teacher. Most teachers have their own methods for motivating and stimulating and making the students more interested. These I cannot discuss here. However, more attention to the profound effect of chemistry on society and the role of chemistry in our daily lives helps bring some of the students around. Applications of chemistry to the chemistry and physiology of the body also aids in stimulating their interest.

The problem of how to make the student work more can be partially overcome by more direct assignments and more attention to the assignments that is, assigning homework and then grading this homework or giving quizzes on the same material. We have also found take home exams where the student can work at his own pace are also effective. We also offer assistance to students in helping them to do additional work by offering a pre-chemistry course in which we teach the language of chemistry and chemical arithmetic in more or less drill fashion.

We cover the material at a very slow pace and concentrate on methods of solving chemical problems and the arithmetic that is an integral part of the problem solving operation. This course is not exactly a remedial course as it is designed primarily for those students who have not had chemistry in high school and who, we precict will not be able to keep up with the pace in our regular chemistry course. We make our prediction, that is, we select students for these courses on the results they obtain in a mathematics placement test plus their high school average. For those students who are especially weak in mathematical skills we have a remedial mathematics course in which the required remedial aid is given to the students.

We also offer what we call "MINI COURSES" for those students who find that they are having difficulty in maintaining the pace and for those students that the teacher thinks needs some additional work. These courses begin six weeks after the beginning of the semester so the student as well as the instructor are aware by this time that the student does need some additional help.

The Mini Courses are conducted four hours each week - 2 sessions for 2 hours. These are recitation sessions where numerical problems are gone over in great detail. The working out of the problem, the numerical calculations, are as much, if not more of a burden to the student, than the setting up of the problem. This remediation in arithmetic as well as the training in chemical calculation, is better training than simple arithmetic drill. The student has been subjected to arithmetic drill throughout his educational lifetime without any observable effect.

In a learning situation such as this mini course, the student learns better because his calculations do not involve isolated numbers in an abstract situation. While working out his chemistry problems he sees the need for, and the application of, his calculations. Apparently he does gain more from this approach. I cannot give you any data on the effectiveness of this course as it was just begun last semester and we only had 1 class of 10 students.

It is interesting to note that the volunteers for the Mini Course are the better students in the class. They are the ones who welcome additional work. Since enrollment is limited, there is no room for these students in the mini course. However, they also gain. One advantage of these mini courses for the better student is that the pace in class can be accelerated because the slower pace needed for the slower student is now available to him in the Mini Course. One instructor has also invited his better students to assist him in conducting the Mini Course. This peer teaching situation works out very well for both the poorer and better student as the poor students can receive almost individualized attention when there are a sufficient number of interested good students. Helping or tutoring is also of benefit to the better student as it helps him to clarify his thoughts so that his explanations can get through to the needy student.

We also have atutorial program conducted by a tutorial center. The problem here is that many tutors do not know sufficient chemistry to clear up the student's problems. Good students aiding the teacher in a mini course I think makes for a better learning situation.

We also have a reading and study skills center where students with reading and writing problems are given individual instruction. Most of our chemistry students do not have fundamental reading problems where they cannot decode individual works. However, many are weak readers - that is, despite the years that they have spent in school, they have not had sufficient reading practice to gain proficiency in a field that we all more or less take for granted.

We cope with the problems of the weak reader by not expecting too much from his first reading of the text. We cannot expect him to go home and prepare for class by reading ahead. We have to cover the material in class and provide reference points and the appropriate basic vocabulary. With this background, the students can then go home and read the assignment for learning and retention.

To circumvent this weakness in reading I try to minimize the number of terms and even concepts to those needed as preparation for advanced courses in chemistry. I believe that once the student has worked through his first year he will be ready to expand his vocabulary. In our chemistry for the health sciences we attempt to provide sufficient background in general, organic and biochemistry so that the student can be successful with his advanced studies.

Introducing Allied Health Students to General, Organic and Biochemistry

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Iowa City, Iowa

Presented to the Symposium on Chemistry for Allied Health Students, Thirty-Third Two Year College Chemistry Conference, Dallas, Texas, April 6, 1973.

A two-semester terminal course in general, organic and biological chemistry is offered at the University of Iowa, where a typical class is 50% pre-nursing students and 30% home economics majors. People who think it impossible to cover all these topics in two semesters should look at the paramedical requirements and interests of the students. The most important single function of such a course is to serve as a prerequisite for other courses of a biological nature, so the course should be structured to help students in biological courses. Judicious choice of topics is necessary, and not all topics "sacred" in traditional chemistry need be presented.

The first semester topics in the course offered at the University of Iowa include metric system, gas laws, solutions, acid-base theory and electrolytes in addition to topics which are direct prerequisites for the second semester such as bonding and geometry of molecules, energetics of reactions, reaction rates, catalysis and chemical equilibrium.

Emphasis is on the functional groups and bond polarities in the second semester with biochemistry interwoven so the student learns to focus on the important parts of the molecules and develops the ability to predict reactions. Hydrocarbons, alcohols, aldehydes, ketones, carboxylic acids, acetals and hemiacetals, heterocycles, amides and amines are among the topics that lead into carbohydrates, proteins, lipids, nucleic acids, enzymes and metabolism.

The laboratory classes, which are taught as separate registrations with pre- and co-requisites of chemistry, contain experiments such as the assay of aspirin and the assay of gallstones, chosen and developed with an eye to the allied health fields, emphasizing fundamentals rather than specific applications.

Students emerging from this two-semester course are not well-versed in descriptive chemistry but they have developed a working knowledge of the fundamental principles governing chemistry and have shown it is possible to readily assimilate biological concepts presented on a molecular basis.

Instrumentation

Instrumentation: Sophomore Organic Chemistry and the Future

D.L. Fishel
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Presented to the General Chemistry Section, the Thirty-Fourth Two-Year College Chemistry Conference, Cuyahoga Community College - Metropolitan Campus, Cleveland, Ohio, May 11, 1973

I wish to address two levels relative to instrumentation in a sophomore level organic course, (A) the theoretical-empirical interpretation level in a lecture course, and (B) the "hands-on" laboratory level.

Over the past fifteen or so years, we have seen a very significant change in the orientation of the undergraduate organic course from a classical reaction-equations based on functional group approach, necessarily requiring considerable memorization, to one in which structure and mechanism have served as a rational basis for classifying organic reactions; functional group chemistry is there but it is secondary. A brief historical perspective is in order.

In the 50's infrared spectroscopy as a tool which depended on instrumentation began to find its way into textbooks, but largely as an appendix, more often ignored as too complex for most instructors to wrestle with in a formal way.

Perhaps one of the earliest pioneers to attempt teaching an appreciation of the practical use of infrared spectroscopy as a tool in the analytical laboratory was Nelson Fuson of Fisk University. He has conducted Summer Institutes for this purpose continuously for about twenty or so years. Many of the attendees of his Institute programs have returned to their own campuses to initiate using infrared spectroscopy in their undergraduate organic chemistry courses.

In 1959 Morrison and Boyd's first edition textbook involving an integrated approach not only between aliphatic and aromatic chemistry but more importantly between mechanistic and structural concepts with classical organic reactions, appeared on the scene and was adopted by large numbers of organic chemistry teachers. The Morrison and Boyd text did not however, introduce spectroscopy or instrumentation in a direct way to the organic curriculum. The results of experimental work depending on instrumentation were presented, often in a very glib and convincing manner, but little connection was made with the origin in the laboratory of those results.

In the lecture classroom one of the first successful integrated approaches was probably that of J.D. Roberts, who in the early 60's introduced P.M.R. as a basically simple approach toward showing an experimental basis for the structure of organic compounds. The success of this was demonstrated in the textbook with M. Caserio (1964) in which a major departure from "tradition" was made by placing a large and important chapter on spectroscopy at the beginning of the book and with integration of the material on spectroscopy throughout.

Since that time, new successfui textbooks or revisions have followed this integrated approach between the interpretation of the experimental basis for structural knowledge and the chemistry of organic compounds. Most instructors now agree that the timing for these concepts in a first exposure should fall somewhere toward the end of the first quarter's work. This gives an opportunity to develop the language and the images of organic chemistry, then to demonstrate the solid structural base in terms of spectroscopic experimental evidence. This approach has been taken with texts devoted to full year courses and also for many abbreviated or terminal courses in organic chemistry.

I think it is now safe to say a lecture discussion of the theory and basis for spectroscopic evidence for organic chemical structure is not only here to stay, it is essential in imparting to the student the evidence and basis we have for our concepts of structure and reactivity of organic compounds.

Unfortunately, the laboratory course has generally not kept up. Few students today have a real hands-on approach to the use of spectroscopic tools or instruments for the study of organic compounds. The reasons for this are largely practical ones. Most of us do not have the budget to equip an undergraduate laboratory with the instruments needed to allow all students to get full exposure to modern spectroscopy.

Nevertheless, most of us have afforded to have the following instruments:

(1) Several gas chromatographs, at least the basic sort, isothermal with thermal conductivity cells as detectors. FID is also now available on an inexpensive model.

(2) An "infracord" type infrared spectrometer (a number are now available at N $3000).

(3) Colorimeters, which extend partially into the ultraviolet region.

Some of us can also have:

(4) An inexpensive 30 or 60 Megahertz proton magnetic resonance spectrometer these now range from $6000 to approx. $11,000.

Few of us can yet consider:

(5) A mass spectrometer of any kind although with the advent of chemical ionization, I predict that mass spectroscopy will find its way into undergraduate lecture textbooks at least to the same extent as infrared spectroscopy if not N.M.R.

What is to be done?

First, let me develop briefly my own philosophy for undergraduate laboratory as it relates to the use of instrumentation and a hands-on approach for students. Our organic laboratory course at Kent State University has been divorced from the lecture course, insofar as records keeping, and to a fair extent even as a scheduled corollary to the course content. That is, we do not feel it is necessary to demonstrate the reactions of specific functional groups at the same time they are being discussed in lecture. I do not argue the pedagogical value of an attempt at such correlation, but we find it of less importance than the development of laboratory skills in an order that will allow an interested student to strike out on his own, to learn organic chemistry by its practice.

I would like to outline our initial approach to laboratory for the beginning student:

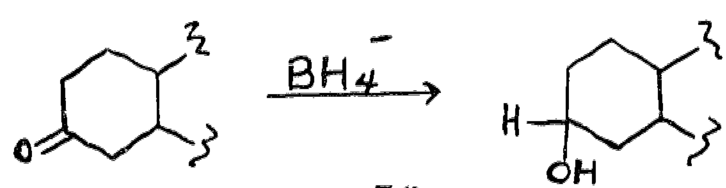
(1) We first introduce skills for manipulating and purifying solids, largely because these are usually easier to work with and afford a measure of aesthetic pleasure to the beginning student. These include:
   (a) solubility tests (the beginning of qualitative analysis)
   (b) recrystallization (including testing purity by melting point)
   (c) chromatography, at first simple column chromatography
   We may also include
   (d) sublimation

(2) Skills for manipulating and characterizing liquids:
   (a) distillation plus the first "instrument", a refractometer, which is the best simple way to establish purity of liquids
   (b) later steam distillation, then vacuum distillation are introduced with appropriate experiments

(3) Further skills for qualitative analysis:
   (a) extraction, with further consideration of solubility differences of organic compounds
   (b) T.L.C. and Infrared analysis

This first exposure to spectroscopic instrumentation in our course is infrared analysis via an experiment which is a simple one: "unknown" samples are provided of a solid carbonyl compound

The experiment itself is a reduction of the carbonyl compound to an alcohol and identification of both.

(1) 

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This is optionally followed with:

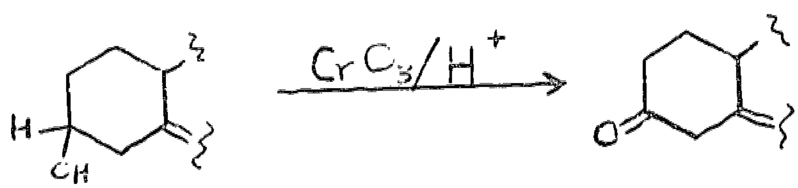
(2) Analysis of the reaction with T.L.C., then:

(3) Purification by recrystallization, the mpt. is used for help in characterization.

(4) The infrared spectrum of starting material and product are obtained to show gross differences between -OH and C=O stretching frequencies.

We have two infrared machines for approximately 180 students which are divided into four spections of approximately 45 per section.

We must do the infrared analyses with student teams and we must schedule with several different experiments overlapping. Very soon after this initial exposure, the reverse reaction is investigated:



The students are encouraged to use the same techniques they employed before and to report on the results:

(1) T.L.C. is a requirement here.

(2) The infrared spectrum is suggested as a follow up.

(3) The techniques of recrystallization are again necessary here to get a good infrared spectrum (the alcohol is usually cholesterol, the product from which is not outstandingly easy to purify).

We also introduce the gas chromatograph as a hands-on instrument relatively early in the course. The first experiment is somewhat artificial; they are given a simple made-up mixture of solvents to separate and identify by relative retention time measurement and by peak enhancement. We feel the bariables involved in gas chromatography are experimentally more difficult to control, therefore we do not expect as much as with the infrared experiment.

Following this initial exposure we make these instruments generally available and suggest that analyses be run routinely on products obtained via preparative experiments. Many of our experiments involve an element of qualitative analysis; that is several different starting materials can be used and are given out as samples. Part of the

Later in the course, although this will likely be moved up in the future pending the acquisition of an inexpensive 60 megacycle instrument, we introduce NMR. This is via demonstration by instructors and graduate students, not at present a hands-on approach. The students own samples are used however, and again the team approach must be employed. What do we see for the future?

As is usually the case, a revolution is occurring under our noses. I predict that in five years all laboratory instruments which depend primarily on electronics for their operation will undergo a drastic price reduction as well as a sophistication of design which will make even a mass spectrometer into a commonly available undergraduate laboratory instrument. Equipment so affected will include:

(1) Gas chromatographs

FID and Electron Capture Detectors will employ cheap solid state electrometers and amplifiers. Total cost will probably be under $50 and most of this cost will be due to hardward machining of cells and metal parts; electronics will cost less than $1-$2.

(2) Infrared and Ultraviolet spectrometers

(3) Nuclear Magnetic Resonance spectrometers

For these instruments the electronics cost will go down by 5 to 10 times. In the latter case (NMR) this will also include the cost of highly stable RF transmitters and magnetic scanning electronics.

(4) Mass spectrometers

The past five years has seen the standard Nier-Johnson instrument go from a cost of approximately $120,000 down to approximately $25,000. This has resulted with the development of (a) all solid state electronics and (b) computer designed electromagnets which are much more efficient, smaller in size and therefore less expensive. In the next five years, Quadrupole instruments will become even more readily available and an instrument suitable for simple research and teaching should be available for less than $5,000.

The slide-rule has recently become a sophisticated electronic calculator and the L.S.I. electronic circuit chip has made them available for approximately $50 to $450 today. Much of this cost is added on by distributors and middlemen. The actual cost of the least expensive is probably under $20.

(5) In the next five years, the computer will be a standard laboratory instrument not only for large research labs, but also for the undergraduate teaching laboratory. It will be used for data acquisition and recording as well as for data reduction.

The great expense of multiple analog recordings from each of many analytical instruments will disappear when all are coupled to a small time-shared computer that can output tabulated data and perform sophisticated computations. Such computers are presently available for approximately $6000. These should go down to approximately $2000 counting all peripherals.

Recommended initial references for Analog and Digital Modules and I.C.s as the "new" approach to chemical instrumentation:

(1) R.G. McKee, "A Modular Approach to Chemical Instrumentation", Anal. Chem., 42, 91A (September 1970)

(2) John S. Springer, "Using Integrated Circuits in Chemical Instrumentation," Anal. Chem., 42, 22A (July 1970)

(3) Raymond E. Dessy and J.A. Titus, "Computer Interfacing" Anal. Chem. 45 124A (February 1973)

Obtaining and Using a Gas Chromatograph in an Academic Chemistry Laboratory

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Presented to the General Chemistry Section, the Thirty-Fourth Two-Year College Chemistry Conference, Cuyahoga Community College - Metropolitan Campus, Cleveland, Ohio, May 11, 1973.

To paraphrase Shakespeare in Julius Caesar, Act IV: there is a tide in the affairs of men (and Chemistry Departments), which taken at the flood, leads on to fortune. In my case, it was not fortune, but gas chromatography. Five years ago, there occurred within our department a unique and propitious series of events that began to exert a continuing and significant influence on our courses in chemistry at Montgomery College. These events were:

(1) I was granted a one-semester sabbatical leave for purposes of advancing my education through the graduate school of a local university. During the course of the sabbatical, I completed several advanced courses in analytical chemistry.

(2) The summer following the sabbatical, I attended the ACS short course entitled Basic Gas Chromatography given in Washington, D.C. by Drs. Harold McNair or V.P.I. and James Miller of Drew University.

(3) Our college was undergoing rapid expansion in enrollment and had decided to enlarge the science facilities through construction of a new 1.2 million dollar science building.

My period of graduate study made me aware for the first time, of the greatly increased use of G.C. in the field of chemistry, while the ACS short course gave me specific information on the theory, uses, instrumentation, and cost of this very important instrumental development of the last 20 years. Like many of my colleagues, my own undergraduate and graduate school background in the 1950's was obtained before G.C. became a widely known and used technique. Academic obsolescence is a common enough problem to all teachers, but one I believe to be particularly acute in the two-year colleges, where research in one's discipline is typically minimal. It was then, the fortuitous combination of my sabbatical and the ACS short course that made me aware of the possibility of using G.C. in the various courses in chemistry at our college.

Without the construction of the new science building however, all of my ambitions might have been for naught. In our state, Maryland, capital funds to support new construction are financed 50% from the state and 50% from the county. Since large sums of money are involved, the cost of furniture and laboratory equipment becomes a much smaller percentage of the total than would be the case if a large amount of money was requested for a particular instrument through the annual operating budget of the college. My experience has shown that budget planning for construction of a new facility is the only time when expensive laboratory instrumentation can be requested with relative assurance that the request will meet with administrative approval. If your college is financed in a similar way, don't be conservative when planning the equipment budget for a new building! It may be your only opportunity to get equipment more sophisticated than beakers, bottles and burners.

As you might have guessed, the purchase of one or more gas chromatographs was high on my list of budget items for equipping the new building. At that time, spring 1969, I found very few companies manufacturing gas chromatographs specifically designed for educational uses. Carle Instruments in Fullerton, California was the best known. Gow-Mac in Madison, New Jersey, had just begun to market their product and Galen Ewing's A.R.F. Products had a gas chromatograph which was a part of its modular instrumentation series. There may have been others, but I was unable to locate them. For several reasons, but most importantly from conversation with people using the instruments, I chose the Gow-Mac for our college. I have not regretted my choice. The cost of setting up the Gow-Mac Gas Chromatograph was broken down as follows:

Gow-Mac 69-100 Basic G.C.	$ 595.00
Gow-Mac Strip Chart Recorder (1mv)	595.00
2 Stage Gas Pressure Regulators and Fittings	75.00
Helium Cylinder (72 cu. ft.) plus Demurrage ($1.60/month)	13.50
6 Hamilton (2.5 microliter) syringes @ $12.00	72.00
Bubble Type Flow Meter (10 ml)	8.00
1/10 Second Stop Watch	40.00
Miscellaneous, including extra chart paper, septums, copper tubing, etc.	50.00
TOTAL COST	$1,448.50

The first gas chromatograph finally arrived during the summer of 1970 and an interested student and I assembled it and began to learn how to use it. During the remainder of the summer and fall, members of the departmental faculty also began to familiarize themselves with the instrument. Their interest in learning about G.C. was enhanced when I incorporated a demonstration with the instrument into our fall laboratory program in our main course offering, CH 101. When each faculty member became aware that he would have to do the demonstration himself for his particular lab class, the motivation to learn became acute. (The fact that I was the chairman of the department, permitted me to introduce such radical changes in course content). In this way, the G.C. was first introduced to the faculty of the department. They then proceeded to teach their students and instruction in G.C. is now a well established part of our course of study.

For those of you in the audience who may not be too familiar with the theory of G.C. (or G.L.C. as it is sometimes called), there are now chapters in most textbooks of analytical chemistry that describe the method rather completely. The theory is even finding its way into some textbooks of general chemistry. Basically, it is a most powerful separation technique which can also be used for both qualitative and quantitative analysis. It is especially good at handling organics which can be volatilized below 250-300°C. Since this temperature range incorporates about 99% of all organic compounds in common use today, the versatility of G.C. is obvious.

The heart of G.C. is its column packing, since this is where the actual physical separation of the components in the mixture occurs. The column packing consists of an inert, solid support phase, typically crushed firebrick or diatomaceous earth which has an extremely large surface area. Each tiny particle of this solid support phase is then coated with a non-volatile liquid phase. There are hundreds of different liquid phases reported in the literature and being marketed today. Each has a specialized use. The Gow-Mac 69-100 is a dual-column instrument, with one column packed with a silicone oil as the liquid phase. The trade name for this liquid phase is DC-200 (Dow-Corning) and its low polarity makes it useful in separating hydrocarbon mixtures. The second column is packed with a polyglycol material whose trade name is Carbowax 20M (Union Carbide). The carbowax column is moderately polar and is thus most useful in separating the components of polar mixtures. Having a dual column instrument provides the operator with a certain versatility and many interesting experiments can be performed using just these two columns. If more diverse experiments are to be performed, columns with different packings can be purchased from several different suppliers for $25-$35 each. It is not difficult to remove a column and install a different one.

A partitioning process somewhat analagous to repeated solvent extractions taken place between the components of the mixture and the liquid portion of the column packing as the mixture is swept through the column by the carrier gas, which is typically helium, but could be any one of several different gases. If there are any differences in the structure of molecules in the mixture, they then interact with the liquid phase in the column in varying degrees. Those that interact strongly will be retained on the column longer than those that do not, assuming approximately equal boiling points of all components in the mixture. Thus, although all components in the original mixture enter the column at the same instant in time, by the time they have traversed the column, they exit one after another. The length of time each component spends in the column is known as the component's "retention time" and is characteristic of each compound, under a given set of experimental conditions such as the nature of the column, temperature and carrier gas flow rate.

There are several types of detectors available today which serve to indicate to the operator when a component is leaving the column. The simplest and least sensitive type is the thermal conductivity detector. A thermistor is used in the Carle instrument while the Gow-Mac model we have uses a gold sheathed, hot wire filament. More sophisticated detector systems include flame ionization detectors, electron capture detectors, et al. The cost of the G.C. approximately doubles when a flame ionization detector system is employed and I understand that they are prone to a number of problems that would be greatly intensified in the hands of an inexperienced operator (student). The thermal conductivity detector is based on the principle that a heated filament will lose heat at a rate which depends on the composition of the surrounding gas stream. The rate of heat loss thus is a function of the composition of the gas surrounding the filament at the time. In the Gow-Mac 69-100 instrument, one electrically heated filament located at the effluent end of one column is continually exposed to an atmosphere of pure helium carrier gas, while the second filament located at the end of the second column is exposed to an atmosphere of helium plus component. A wheatstone bridge type of circuit continually measures any imbalance between the resistance of the filaments. Recall that the resistance is a function of the filament temperature, which in turn is a function of the atmosphere surrounding the filament. An imbalance in the circuit appears in the form of a peak on a strip chart recorder, which is continually plotting circuit balance against time. Marking the time of the injection on the chart paper and knowing the chart speed (2inches/minute is common), it is possible to directly measure the retention time of a component by measuring with a ruler from point of injection to point of component peak. As noted earlier, the retention time can be used in the qualitative analysis of the component. The peak height (or area) can be used for quantitative analysis. A block diagram of a typical G.C. would then show the necessary components.

At Montgomery College, we are using G.C. in four different courses: (1) In our general chemistry first-semester lab, the instructor introduces the topic by means of a four-minute, silent Super 8 film loop on G.C. done by Rod O'Connor (Harper & Row Films). At the beginning of the semester, the student has received an outline on the theory of G.C. in his laboratory packet of instructions, so he is supposed to have read about it before coming into lab. Following the showing of the film, the instructor then demonstrates to the class how a liquid sample is measured into a syringe, injected and a chromatograph obtained. For the demonstration, we use a 50:50 mixture of n-heptane (B.P. 98°C) and n-propanol (B.P. 97°C). We inject first on the carbowax column (the polar one) and then on the DC-200 column (the non-polar one). The order of elution is reversed on the two columns, but the two compounds are very effectively separated on each. Following the demonstration, a discussion concerning theory, terminology, technique, etc., ensues. We will frequently find students staying late or coming around for more information at a later time, which I have always felt is the best indicator of student interest in a topic.

(2) In organic chemistry, students use the G.C. themselves, after having been certified by an instructor as to their competency. The method is used by the organic student to follow the progress of a typical fractional distillation, that of CCl_4 and benzene. The various temperature cuts are chromatographed and the results offer striking visual evidence of the efficiency of the students' distillation. At other times, the organic students routinely use the G.C. to check on the purity of the products of their syntheses. In this way, they develop quite a sense of pride in being able to demonstrate a "pure" product. As mentioned earlier, a special column is needed to separate and identify amines or the products of an esterification reaction, since any mixture that contains water cannot be handled effectively using the columns that originally come with the G.C.

(3 & 4) In analytical chemistry and in our honors course, the G.C. has been used in student individual project work. The projects have involved testing of consumer products such as different brands of cigarette lighter fluid, paint remover, spot remover, and in a most ambitious project, automobile gasoline. The spot removers were tested for the presence of illegal carbon tetrachloride as well as other chlorinated hydrocarbons. The gasoline project was an attempt by an honors program student to analyze low-lead or lead-free gasolines for increased aromatic content. The student was made aware that gasoline manufacturers were introducing aromatics into their gasoline mixtures at the refinery in order to hold the octane rating high while reducing or removing entirely the additives tetramethyl and tetraethyl lead. In order to separate and identify the aromatics, we relied on Gow-Mac's advice as to a proper column to use. We were told that dinonyl

phthalate or DNP had been used successfully for such a separation. Tricresyl phosphate had also been used. We ordered the chemical and proceeded to build our own column which was then substituted for one of the two in the Gow-Mac instrument. After overcoming a number of plumbing problems, the student was able to show an increase in the aromatic content of a popular brand of non-leaded gasoline as a function of the increased cost per gallon of that brand of gasoline. In carrying out the project and particularly in building his own column, I feel the student learned a great deal about chemistry in general and G.C. in particular. Studies have also been done by our analytical chemistry students on the effects of varying experimental conditions on peak heights, shapes, and retention times. Calculations of number of theoretical plates and height equivalent to a theoretical plate (HETP) have been made.

Two former students, now chemistry majors at a local university, recently returned to our department to use our G.C. as a preparatory instrument to purify a new organic chemical they had synthesized. They did this work over the past Christmas holiday and modified our instrument so that they could collect the desired component fraction out of the effluent stream by condensing out the fraction using a low temperature trap.

In addition to the 8 mm film loop mentioned earlier, other methods to teach G.C. involving programmed instrumentation via audio cassette and slides (Communication Skills Co., Fairfield, Connecticut, @$80.00 for 43 slides and a 23-minute cassette on Basic Relationships and Instrumentation) as well as an ACS audio tape presentation of the short course are now available. Sadtler in Philadelphia also has similar programmed instruction. Since I have no experience with any of the series, I can offer no comment as to their value.

I have found the following sources of information to be quite helpful:

1. The instrument manufacturer. If his literature is not sufficient, a simple phone call to the manufacturer's technical staff will often suffice to answer most questions. Gow-Mac has been most cooperative in this respect.

2. The textbook Basic Gas Chromatography by H.M. McNair and E.J. Bonnelli, 5th ed., 1969, @ $5.00. This is the text that was provided to the participants in the ACS short course. It is a well written book for the beginner in G.C. and should be a part of any chemical library.

3. Catalogs from major suppliers of chromatographic materials, such as Applied Science Labs, Inc., in State College, Pa., and Supelco, Bellefonte, Pa.

In conclusion, as I looked at the impressive title Professor Mooney had assigned to my part of the program tonight, I was reminded of the scriptual passage from Ecclesiastes, "There is no new thing under the sun." The experiences I have had with G.C. at Montgomery College are not really that "innovative" and I am sure that many of you in the audience tonight have used this instrument in far more clever ways than I. I hope, however, that those of you new to the subject, or hesitant to get started, have learned a few things here this evening that will stimulate you to acquire and start using a G.C. in your department.

L'Approche De La Chimie Organique Dans Les Cegeps Du Quebec

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Presented (in French) to the Organic Chemistry Section, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 8, 1973.

Je suis fier de présenter à mes collègues américains et canadiens de la chimie, comment la chimie organique est offerte aux étudiants, des Cegep du Québec.

Tout d'abord, la formation d'un étudiant en chimie organique, s'effectue à l'aide de deux cours, comprenant chacun 75 heures, se divisant en 45 heures de formation théorique et 30 heures de travaux pratiques, soit les laboratoires.

Même si la formation en chimie organique est produite à l'aide de deux cours, je vais considérer l'approche, surtout en regard avec le premier, car, le deuxieme repond sensiblement a une continuite de ce premier.

Actuellement, le chimie organique se donne aux étudiants en concentration sciences de la santé "médecine pharmacie, art dentaire, etc", mais, l'approche qui est maintenant en vigueur a été faite, pour une éventualité prochaine, d'offrir ce premier cours aux étudiants de sciences physiques "chimie, biochimie, biologie, microbiologie, etc" et il serait pour eux un cour terminal.

Il y a à vrai dire, deux manières pour commencer l'étude de la chimie organique. Premièrement, il y a la méthode descriptive, soit l'étude par les fonctions, par l'apprentissage d'un grand nombre de réactions, avec une description explicative des mécanismes qui s'effectuent. Deuxièmement, une étude surtout d'ordre structurale, par la connaissance de la stéréochimie, par la connaissance des facteurs influencant la réactivité des composes tels les effets inducteurs stériques et pour en arriver à une compréhension des mécanismes réactionnels, qu'on peut appliquer par la suite aux fonctions concernées soit les alcools et dérivés halogènes dans le cadre des mécanismes de substitution et d'élimination. Cette dernière méthode a l'avantage, de faire appel plutôt au raisonnement et à la logique, qu'à une somme assez imposante de connaissances à apprendre.

Comme au Quebec, il y avit des des adeptes des deux méthodes, l'approche que nous avons actuellement const tue un compromis entre ceux-ci.

Ainsi nous avons l'approche suivant:

En premier lieu nous caractérisons la nature d'un composé organique.

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Ceci fait, nous présentons les principales fonctions; "alcanes, alcènes, dérivés halogénés, alcools, etc"; ensuite nous caractérisons les groupements fonctionnels de ces fonctions pour passer aux règles de nomenclature U.I.C.P.A., afin que l'étudiant, voit l'étendue et possède un langage ordonné de la chimie organique.

Pouvant maintenant distinguer les fonctions et situer des composés, nous poursuivons avec la stéréochimie des composés pour ensuite passer à la réactivité des composés organiques, en étudiant systématiquement les facteurs, pouvant influencer cette réactivité.

A ce point, l'étudiant possède une connaissance de la chimie organique du point de vue statique seulement, mais il est en mesure d'aborder l'aspect dynamique par l'étude des réactions entre les composés; ce qui implique qu'on commence à ce moment une introduction aux mécanismes réactionnels.

Pour cette introduction aux mécanismes réactionnels, nous étudions presqu'uniquement au point de vue général les mécanismes de substitution, d'élimination et d'addition. Nous ne considérons pratiquement pas les catégories de substitution ou d'éliminations tel les S_n1 ou S_n2 ou E_1E_2. Ces divisions apparaitront lors de l'étude des fonctions, où l'on recontre ces dits mécanismes. Un point sur lequel nous insistons pour faciliter la compréhension des mécanismes, est la connaissance adéquate au niveau électronique, de ce qu'est une base et un acide de Lewis ou en d'autres mots, un nucléophile et un électrophile, car les réactions organiques se résument toujours à des réactions acides-bases de Lewis ou réaction nucléophile-électrophile.

Finalement, par la connaissance des comportements réactionnels nous terminons par une étude un peu plus descriptive des fonctions déjà presentees;

Les alcanes

Se caractérisant par les mécanismes radicalaires.

Les alcènes

Se caractérisant par les mécanismes d'addition et la règle de Marhowni kow.

Les alcynes

Permet de faire ressortir à titre de renforcement les mécanismes d'addition.

Chimie du benzène

L'étude des propriétés particulières de cette structure.
L'étude des mécanismes d'addition et de substitution électrophile et l'étude de l'orientation de la substitution sur un noyau benzénique déjà monosubstitué.

Derives halogènes et alcools

Ces deux fonctions sont idéales a l'étude plus détaillée des mecánismes de substitution S_n1 et S_n2 ainsi que ceux d'élimination E_1 et E_2 avec la connaissance de la règle de Saytzelf.

Ainsi cette méthode d'approche nous permet de compléter plus rapidement la formation en chimie organique au deuxième cours par l'étude des fonctions aldehydes, cétones, éthers, acides et dérivés, amines, etc et conserver ainsi un certain laps de temps à l'intérieur de ce cours pour une introduction à la biochimie.

Chemical Technology Programs

Chemical Technology Programmes in Ontario

David Dean
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Presented at the Chemical Technology Section, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 8, 1973.

The purpose of this talk is to give a general picture of chemical technology programs in the Province of Ontario. Rather than discussing the details of individual programs at different colleges, I should like to concentrate on discussing the concept of a chemical technologist as understood in Ontario and the way in which we attempt to produce such a person. This would be the most informative approach I believe, since this is an international audience and many different interpretations are placed on the word "technologist". It is also highly probable that the type of secondary school education leading up to enrollment in a chemical technology program will be very different in the many states and provinces represented here, so I would like to give a brief look at the total secondary and post-secondary educational scene in Ontario.

Secondary education in Ontario has for many years been either a four year (grade 12) or five year (grade 13) program. This is presently undergoing a change to a credit system whereby a secondary school graduation diploma will be granted to students completing 27 course credits. The grade 13 or Honours graduation diploma is usually required for University programs and grade 12 or a general graduation diploma is required for entrance to a technology program in college. For chemical technology, math and science (physics and chemistry) and English are required subjects.

Ontario has 14 publicly supported Universities, 22 Colleges of Applied Arts and Technology (CAAT's), and numerous other professional schools such as Art Colleges and Nursing Schools. About 183,000 students are in full-time attendance at these post-secondary institutions. The Colleges of Applied Arts and Technology grew out of the Province's "Institutes of Technology" and are intended as career oriented institutions with terminal programs. By this I mean that the colleges were never intended as transfer schools, but rather as an alternative to University for those desiring post-secondary education. The diagram (fig.1) illustrates the alternative educational routes available to students leaving secondary school at different stages. Note that CAATs encompass a very broad range of programs. It is the 3-year program from which the technologist is graduated and that is the one which I will discuss today. I should like to note in passing that lateral transfers between programs in the colleges are often made, such as between 2-year and 3-year programs, as well as transfer from college to university programs or vice-versa. Thus while mobility is retained, programs are designed for their own end and not to satisfy any transfer function to another institution.

FIGURE I

Educational Flow-chart

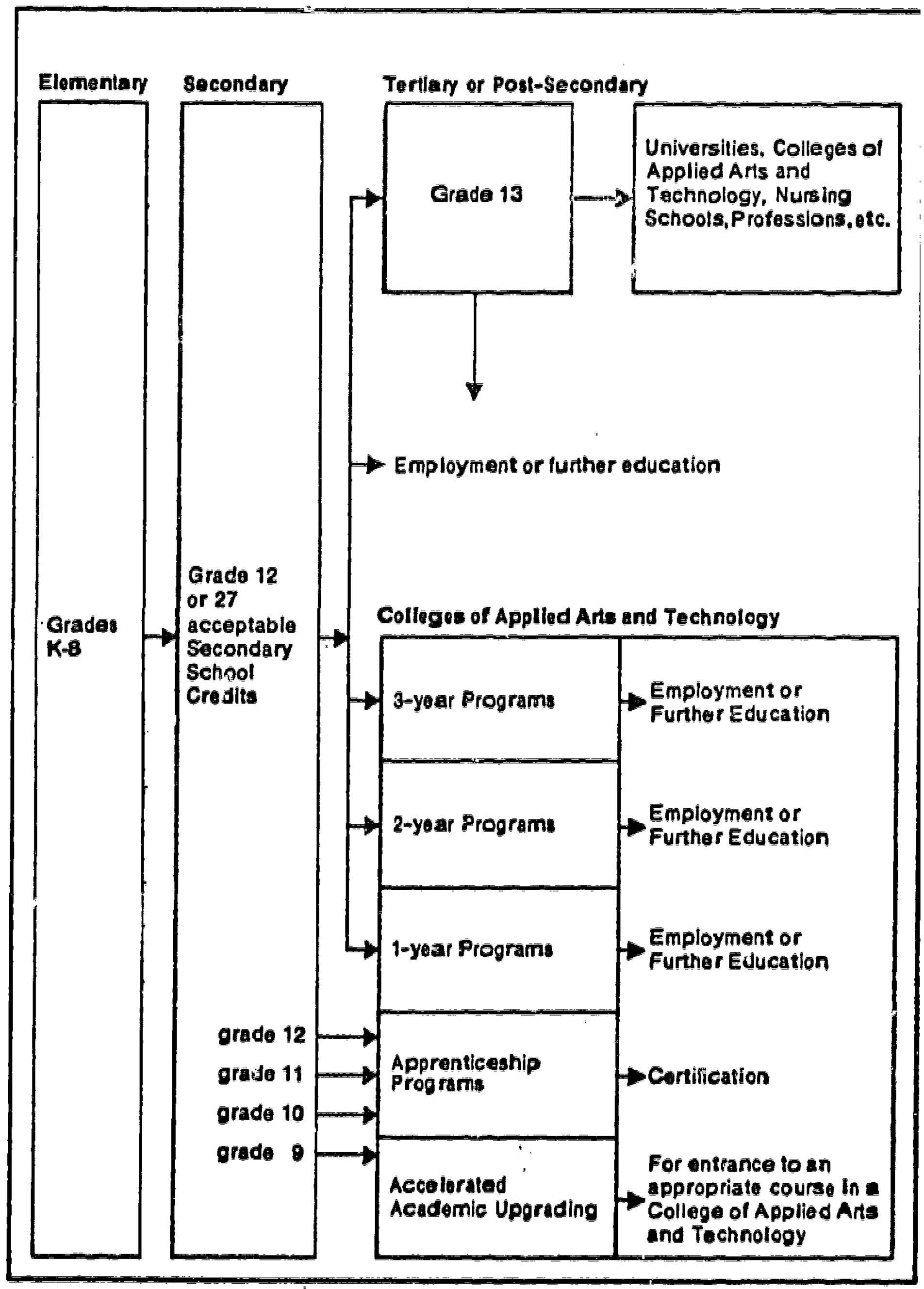
1
Honour graduates of the Four-Year Programs may be accepted for enrolment in a 3-year college program.

2
Grade 13 graduates may be accepted with advanced credits to certain programs.

3
An applicant who does not have a clear admission may be given the opportunity of writing qualifying examinations.

4
After assessment, deserving applicants may be eligible for advanced standings and/or for accelerated programs.

5
REFER TO THE OFFICIAL COLLEGE PUBLICATIONS FOR SPECIFIC ADMISSION REQUIREMENTS, AND DETAILED INFORMATION ON PROGRAMS.



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The terms "Chemical Technologist", "Senior Technician", "Laboratory Technician", "Chemical Technician", and other similar phrases mean different things to different people and perhaps they all mean the same thing to some people. I believe most Canadians, and certainly most of my colleagues from Ontario would accept the description following as that suitable for a Chemical Technologist.

"The Chemical Technologist is a man or woman whose academic training lies somewhere between the professional chemist or chemical engineer and the chemical technician. He is expected to have sufficient knowledge of his subject to solve new problems by the application of chemical principles, and should be able to analyze problems and recommend new procedure or changes to procedures for relatively uncomplicated systems. He would normally take direction from a chemist or engineer but would handle the routine collection of data and analysis on his own initiative. He may direct the work of one or more technicians and should himself be sufficiently competent in laboratory procedures and techniques to train laboratory personnel".

I admit that this is a fairly broad definition, but it is consistent with the type of work being done by our graduates. For example, recent graduates have been employed as lab analysts for the Health Protection Branch of the Provincial government; field analysts for the Department of Inland Waters, Federal government; a packaging engineer for a drug manufacturer; production supervisor for a winery; a chemical equipment supplier; production engineers for a steel company pilot plant, and other diverse activities. The emphasis therefore, is on flexibility and the college programs are designed to achieve this feature.

Let me at this point contrast the technologist with the chemical technician, since this is an important distinction and often causes confusion. The technician generally requires much less theoretical knowledge about his subject, but considerable laboratory technique. Usually the technician is a very different person than the technologist, content to handle more routine lab tasks and work under close supervision. The technician is not just a junior technologist, but is rather a distinct entity in the same way that a technologist is not a junior or second rate chemist but has a unique job function.

Having thus established the nature of the chemical technologist let me now look at the college curricula as a means of achieving the unique product about which I have been speaking. Although the 14 CAATs which have chemical technology programs do not have identical curricula, they are similar enough to be treated collectively for purposes of discussion in this paper.

Figures 2, 3 and 4 show the course content for the first, second and third years of the chemical technology program at Mohawk College. All students taking Engineering technology programs at Mohawk take a common first semester and essentially a common second semester. This has the advantage of allowing students to transfer between programs at the end of the first year with minimal inconvenience and also permits the broadening of background we require for work done in subsequent years. An orientation course in the second semester which is non-credit, is used to give students a better idea of what they may expect to find in industry. Former graduates have been brought back to the college to participate in a discussion forum with the students; films are shown; and the students are asked to work on display cases with the subject matter being any chemical topic of their choice.

Figure II

FIRST YEAR
PROGRAM OF STUDIES

FIRST SEMESTER

NAME	HOURS PER WEEK Lec.	Lab
Chemistry	3	2*
Electricity	3	2
Engineering Drawing and Applied Mechanics	2	2
Communications	4	-
Mathematics	5	-
Physics - Mechanics and Heat	3	2*
Physical Education	1	-
Orientation and Counselling	2	-

SECOND SEMESTER

NAME	HOURS PER WEEK Lec.	Lab
Applied Mechanics	2	-
Chemistry	3	4
Electricity	3	2
Lit. and Language	4	-
Mathematics	5	-
Physics - Sound and Light	3	2*
Physical Education	1	-
Orientation and Counselling	2	-

*Alternate weeks

In the third and fourth semesters, the student has his first substantial introduction to organic chemistry, analytical chemistry, and physical chemistry. There is a separate laboratory for each course and emphasis is placed on techniques and familiarization with equipment. In the organic lab, for example, students first learn to assemble a desired experimental configuration using ground glass apparatus; how to prepare melting points; make a steam distillation; and other techniques basic to organic preparations and purifications. After the first few weeks they learn how to prepare a sample and run an infra-red spectra so that during the year they routinely take the I.R. spectra of material they have prepared. They take enough theory in I.R. to learn to identify major functional groups and some fine structure, but the main point is that they begin to work with I.R. early and routinely which permits much more detailed study in subsequent courses.

Figure III

SECOND YEAR
PROGRAM OF STUDIES

THIRD SEMESTER

NAME	HOURS PER WEEK Lec.	Lab
Organic Chemistry	3	3
Inorganic Chemistry	2	-
Analytical Chemistry	2	3
Physical Chemistry	3	3
Mathematics	4	-
Basic Electronics	2	2
Liberal Studies Elective	3	-

FOURTH SEMESTER

NAME	HOURS PER WEEK Lec.	Lab
Organic Chemistry	3	3
Chemical Process Industries	2	-
Analytical Chemistry	2	3
Physical Chemistry	3	3
Mathematics	4	-
Modern Physics	3	1
Liberal Studies Elective	3	-

Physical chemistry labs have students working with all types of measuring devices. They work with several types of constant temperature baths; learn to take pressure and temperature measurements; work with rheostats and power supplies; potentiometers and multimeters; take viscosity and surface tension readings; operate bomb calorimeters and run distillation columns. This type of lab is also ideal for collecting data which can then be analyzed graphically and which also permits the student to apply methods of analysis learned in mathematics under "empirical equations".

Analytical chemistry follows a fairly classical approach of volumetric and gravimetric analysis, with some chromatographic and simple instrumental methods.

The mathematics program covers basic calculus, nomography, empirical equations, and computer programing. The electronics and physics courses are designed to give the student the operational fundamentals used in instrument design. Such areas as optics, monochromators, prisms and gratings as well as amplifiers and detectors help the student appreciate the capabilities and the limitations of the equipment he uses.

Part of the "general educational component" of each student's course is satisfied by choosing one of several elective courses. These include courses in literature, language and the social sciences, and are usually only one semester in length so that two different courses are taken in one year.

Figure IV

THIRD YEAR
PROGRAM OF STUDIES

FIFTH SEMESTER

NAME	HOURS PER WEEK Lec.	Lab
Organic Chemistry	2	3
Industrial Chemistry (Unit Operations)	3	4
Analytical Chemistry	2	3
Chemical Instrumentation	2	3
Mathematics	6	-
Manufacturing Management I	2	-

SIXTH SEMESTER

NAME	HOURS PER WEEK Lec.	Lab
Organic Chemistry	2	3
Industrial Chemistry (Unit Operations)	3	4
Chemical Instrumentation	2	3
Mathematics	5	-
Manufacturing Management II	2	-
Metallurgy and Material Science	2	2
Technical Report	2	-

The fifth and sixth semester courses extend and broaden the material from the second year program of studies. There is also more integration of material between courses such as between organic chemistry and chemical instrumentation. In organic chemistry the lab program concentrates on the systematic identification of organic compounds by chemical and physical methods. Students use spectroscopic methods; elemental analysis; fluorescence spectroscopy; gel permation chromatography; polarimetry; Karl Fischer and Kjedahl methods among others. By suitable scheduling the instrumentation lab and organic lab are scheduled on the same day; one in the morning and the other in the afternoon. A student may then be assigned a problem of major importance which is supervised by both his organic and instrumentation instructors. In this manner, lab work becomes more realistic and directed to problems of industrial importance.

Although the students use instrumental methods of analysis beginning in the third semester of their program in organic, analytical and physical chemistry, there is never enough time devoted to these methods to investigate various methods of sample preparation, instrument operating parameters, and different types of instruments available to do the job. The Chemical Instrumentation course is designed to meet these needs. Students work with atomic absorption, flame photometry, I.R. and U.V. spectrophotometry, gas chromatography, NMR, fluorescence, DTA and TGA and gel permeating chromatography. Near the end of the sixth semester the students must do a project in which they design and carry out work of their own choice using some of the instrumentation they have studied.

The Analytical Chemistry of the fifth semester deals primarily with electroanalytical techniques and includes potentiometry, specific-ion electrodes, electrogravimetry, coulometry, polarography, conductivity, and electrophoretic methods.

The inclusion or exclusion of an Industrial Chemistry course is probably the area where there is most digression between programs at different colleges in Ontario. The industrial chemistry courses with an accompanying pilot plant laboratory is essentially an introduction to chemical engineering. Rather than follow this approach some colleges prefer to spend more time with analytical chemistry or perhaps to allow options such as environmental chemistry or polymer technology. It would normally be expected that colleges would adapt their programs to suit the needs of local industry if this is where their graduates are finding employment.

In the Hamilton area, a survey of employment possibilities a few years ago indicated approximately as many jobs were available in chemical production or pilot plant facilities as were available in research or quality control labs. For this reason Industrial Chemistry is a major course in the final year of the program. The physical chemistry course in the second year is a necessary prerequisite and serves to introduce major topics such as distillation, liquid-liquid extraction, gas absorption, and others. The laboratory for this course is also the first opportunity students have to perform chemical operations on equipment other than bench scale. For example, the simple lab function of filtration, changes from a funnel to a filter press in the pilot plant and factory, yet most students would be totally unaware of this without exposure in the industrial chemistry course.

The mathematics course is another area where colleges differ in their approach and emphasis. If the math courses in a program are viewed only as a means for understanding and solving problems encountered during the college program, then math tends to be de-emphasized in the final year. Feedback from our graduates, however, has indicated that many of them have been able to advance in their jobs, primarily due to a better math background and in some cases are pursuing advanced courses. The course at Mohawk College is divided into numerical methods, computer programming, and statistics. The statistics part takes two periods per week for the fifth and sixth semester, and is proving to be one of the most important tools for the graduates.

The computers and numerical methods part of the course covers many important concepts. Students are introduced to analog and digital machines, remote terminals and desk top computers. Routine applications are stressed such as catalogued I.R. spectra, inventory control, and x-ray diffraction data, and the use of computers in the simulation of experimental data is illustrated. Many skeptics believe that the rather limited mathematical background of our students limits their ability to solve real problems using computer methods. A great deal can be accomplished however, and typical student programs include a comparison of the Ideal Gas Law equation with Van der Waal's or other empirical equations; statistical calculations such as mean, standard deviation and frequency distribution of a sample; calculation of theoretical stages in a fractional distillation system using Raoult's Law; and Fanning equation calculations for fluid velocity, Reynold's number, and pressure drop in a pipe. More details of this Math course will be available soon, since we plan to publish some of this work, but this should serve to illustrate what can be done and how this can be made relevant to chemical or chemical engineering problems.

The students technical report listed as a sixth semester subject is usually part of most technology programs. The report is often based on a summer job but not necessarily so. At Mohawk College the student may do either an extensive literature search or an experimental program for his T.R. Many students choose to do experimental work such as comparing a wet analytical method of analysis with an instrumental technique. Technical report topics have included analysis of mercury in fish samples; trace metal analysis in local water supplies; insecticide residue in streams; metal analysis by x-ray techniques; ion exchange methods for decontaminating radioactive milk supplies and a host of other interesting and relevant topics.

In addition to the work done as part of each course, students are encouraged to get some industrial lab experience. To ensure that everyone gets some experience, arrangements are made to have every third year student work in a lab for two weeks as part of his studies. This work is done without pay and employers cooperate very well in finding typical lab work for the students. Several of these work experience periods have led to full time employment for the students after graduation.

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Chemical Technology Programs in the U.S.A.

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Presented to the Chemical Technology Section, the Thirty-Fifth Two-Year College Chemistry Conference, Ahuntsic College, Montreal, Quebec, Canada, June 8, 1973.

As approximate figures for departure, let us estimate:

(a) that there are 80,000 technicians employed in various industries in the United States (see 1969 conference report);

(b) that in 1969 there were at least 88 schools offering training programs with 56 of these reporting students "specifically enrolled" in programs which have chemical engineering or chemical laboratory orientations(1)

(c) that in 1972, 60 schools and colleges offered training in chemical technology, chemical engineering technology--including plastics (2)

(d) that in 1972, 53 institutions granted 340 certificates or associate degrees in these same areas and 2 institutions granted 6 bachelor degrees in chemical technology(2)

Although the number of schools offering training and the schools granting degrees do not quite match, they do give us another approximate figure for departure. Realizing that most of our formal training programs for chemical technicians have been introduced within the last decade, therefore it is safe to conclude that most of the 80,000 working technicians were trained elsewhere.

Men, who have been traditionally employed as technicians in the areas of chemical processing and engineering, were frequently chosen for these positions after working in other capacities in the plant. Recruitment among high school graduates however, is a frequent practice today. Originally these men were trained in apprentice-like situations. More recently, this practice has been combined with more organized training experiences, which range from seminars through scheduled courses offered in the plant or at cooperating institutions.

Men and an increasing number of women have been employed to assist the research chemist. As a rule, more formal techniques were used to recruit them among people with varying exposures to chemistry courses on the college or university level.

"The youthfulness of chemical technology (training programs) is reflected by the average age of the ....programs, 6.85 years. The median of the range was only 4 years and the range was 0-46 years."1 The new training programs have appeared, principally, on the post-high school level, as indicated in a report of a 1969 survey[1] including only 7 high schools among 88 institutions known to offer chemical technology at the time. The post-high school programs are generally offered in technical institutes and two year colleges, both requiring high school diplomas (or equivalency) for admission. Six of the 88 schools offered four year degree programs, all "aiming at a broadly based program in chemistry and a few are making the base even broader by adding biology."[1] While at least two of them are known to exist which are designed to train laboratory workers for the chemical industry in shorter training periods, most of these offerings require two or three years for completion.

Thus, although the numbers are not very firm, the programs do exist today. A few were pioneering before World War II. Several others joined the ranks in the late '40's and early '50's. All tend to be plagued by:

(a) low student appeal--with many students entering for negative reasons

(b) low administrative appeal--with large equipment costs combined with small class sizes creating special budget demands

(c) low faculty appeal--since a good chemical technology teacher is "built", not made (In my own case it took four to five years of patient constructing on the part of my colleagues to get me to begin to appreciate the type of training technicians require.)

(d) less than ideal cooperation from industry--which must enter into the training of chemical technicians at levels which are unique to technologies of this nature. Few companies recognize the need to constantly retrain even the best teachers; the need to provide students with positive images through field trips and work study programs; and the need to assist in recruitment efforts in order to attract sufficient numbers of highly motivated students.

In the face of these difficulties, it isn't surprising that the number of exisiting programs is small and constantly changing. Survivors generally offer either a laboratory or engineering emphasis separated into categories which resemble many areas pursued by the professional chemist or engineer. This likeness is noticeably absent from a recent, encouraging development in the chemical technician training picture. The ChemTeC Project was proposed by the American Chemical Society and funded by the National Science Foundation in 1969. A group was assembled to "prepare instructional materials for approximately 30 semester hours of work for the chemistry core of two year post high school chemical technology programs."[1]

With respect to future development--if the programs survive--the problem of proliferation may need attention. In the United States, there is already a rather sharp division between medical and chemical laboratory training. Increasingly new titles and perhaps new departments have appeared proposing to train technicians to work in the areas of water pollution, air pollution, environmental, ecological, soil, plastics, clinical biomedical, nuclear, marine biology, natural resources, science laboratory, oceanographic, bio-chemical, pharmaceutical, ocean floor mineral discovery, underwater engineering, biomedical equipment, chemical instrumentation...etc. I think you get the point!

The titles above suggest if they do not demand, an interdisciplinary approach to developing a broadly based technician who can subsequently specialize in one of the areas listed.

[1]Technician Education Yearbook 1971-1972

[2]Reports of the Engineering Manpower Commission

(a) Engineering and Technology Enrollments Fall 1972

(b) Engineering and Technology Graduates 1972

Curriculum Development

The System Shapes the Form of the Objective

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Presented at the Symposium on The Systems Approach to College Chemistry Teaching, the Thirty-Fifth Two Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 6, 1973.

A behavioral objective is a statement, a statement which describes what a student does. It can be explicit (State Le Chatlier's principle) or broad (Given a description of an appropriate chemical system, describe what will happen when the system is perturbed by temperature, pressure, concentration, addition of a foreign substance, and account for the direction and magnitude of the predicted changes). If the objective is too broad (Tell all you know about the perturbation of chemical systems in equilibrium) it becomes non-behavioral and ineffective both as a teaching-learning tool and as a means of valid evaluation of a student's competence.

For many years, many teachers have used the broad non-behavioral objectives as a primary teaching tool; with the advent of emphasis upon real behavioral objectives many of these teachers have said that they tell the student what is expected and how their competence will be evaluated. That is, despite the lack of utility of such very broad objectives teachers have used inferences from the students' responses in order to affirm that the student has or has not learned. I would like to suggest that criticisms of the use of behavioral objectives are largely based upon alleged mis-use of the same kind of inference, even though such criticism is misplaced.

A behavioral objective is an explicit or moderately broad statement describing a student's action. From our observation of that action, we are willing to infer that the student has (or has not) achieved a degree of competence in a particular area of chemistry. Generally, an inference from a single observation is tenuously valid, and we typically reinforce the validity by requiring observations of two or more related actions. One can never be sure, of course, that the student is really competent.

For example, to help the student learn, it is common practice to disclose the objectives to the student in advance. At least in some instances, it is possible for a student to then acquire an ability to perform the required action in a superficial manner so that any inference we might make about real mastery is false. Explicit behavioral objectives, particularly, tend to suffer from this fault. To ask that the principle of LeChatlier be stated does not necessarily permit a valid inference that the student can do anything more than this. To ask for a specific demonstration of an application of that principle is equally risky.

If we wish to infer with some validity from students' actions that they have mastered LeChatlier's Principle, we ought then to ask both for the specific, state the principle, and for several applications either as problem work or qualitatively, depending upon the level of sophisticated comprehension that is appropriate to the overall goals of the curriculum.

This then is my first point. The system of student-teacher-curriculum goals does shape the behavioral objective. It is necessary to always remember that we can only infer competence from a performance we observe in a student, and a single inference may be faulty. The system demands, for reasonably valid inferences of competence, that we use broad objectives which are testable by a variety of challenges, test questions, laboratory work, or the like. If this is correct, then it is usually a mistake to use explicit objectives alone and to then disclose such specific objectives to our students. The system we work with too easily permits a student to only memorize what will later be asked for if the objectives are explicitly stated.

On the other hand, if we stop here, asserting that the only good behavioral objectives are broad enough to permit the use of a variety of testing challenges (so that the student cannot merely memorize what he is to do) we miss an important corollary. It is proper to use behavioral objectives as teaching tools such that the objectives are disclosed to the student, in advance, for his use in planning his study of the subject. It is reasonable that such objectives should only infrequently be explicit, with only one answer to be memorized. This use of objectives is related to the student as one who teaches himself, with teacher guidance.

Another use of behavioral objectives is related to the teacher as one who plans the work to be surmounted, who determines the order of presentation. And here we run into a real difficulty. For example, many teachers seem to assert that the best way to learn a subject is to begin at the foundation, with the basic principles, and work upward building upon those essentials. Therefore, they assert, a student must learn about logarithms before he is taught about pH. A student must learn the first law of thermodynamics before he attempts mastery of the second. This nonsense has impeded much of our efforts to teach. Logarithms <u>are</u> necessary for a complete mastery of pH, but they are psuedo essential for a qualitative mastery. The first law, similarly, is a pseudo essential for mastery of the second law--these two principles are interrelated only at a very sophisticated level. As teachers of the subject, we ought indeed to possess a sophisticated mastery of these kinds of topics, but it is often a mistake to teach beginners to initially achieve the same goals. Stated axiomatically, the way in which a subject is known was not the way it came to be known. The real essentials of learning are different from the real essentials of the subject itself.

To teach pH, then, or the second law, it is necessary to ask "What does the student know, now?", "What do I want him to know, later?", and "How do we progress from here to there?". To take pH as our example, the ultimate goal might be to recognize changes in pH during a titration--which implies behavioral objectives related to the use of indicators, or the operation of a pH meter. Indeed, if our ultimate goal did involve logarithms and pH problem solving, the indicator or pH meter use might then very well be an intermediate goal, after which we would include mastery of logarithms as another, following, intermediate goal, and then, finally, the ability to solve problems involving pH.

Now, as soon as we ask questions about entry behaviors, inferred abilities the student brings with him initially; as soon as we ask questions about exit behaviors, and inferred abilities about the matters that have been learned; and when we ask questions about how to get from entry to exit, we immediately raise questions about teaching techniques. These questions are most efficiently answered by the preparation of explicit, detailed, specific, non-general, behavioral objectives. Contrary to the earlier remarks, which disparged explicit behavioral objectives presented to the student, it is suggested that such explicit objectives must be prepared by the teacher.

When we know in detail how we propose to take the student from entry to exit behavior, and only then, can we prepare the non-explicit objectives for student use. In a word, explicit behavioral objectives are useful to the teacher as he prepares his teaching strategy.

Experience in the design of pre-laboratory instruction in beginning chemistry laboratory technique is cited here as an example. (At this point I wish to acknowledge the support of the McGraw Hill Publishing Company, of my co-author, Nicholas Fiel, and of the McGraw Hill editor, Ms. Nancy Marcus, in the work described.) The slides we saw earlier were taken from this work.

For example, then, suppose we wish to teach a student how to bend a piece of glass tubing into a reasonably neat "ell" shape. Between entry and exit for a typical beginner, there are more than fifty different, explicit, behaviors to be mastered. No wonder most students do not bend glass well on their first several attempts. If we as teachers are not aware of the explicit, different, behaviors to be mastered, we can only teach them unconsciously, or lacking that, the student can only acquire them casually, and inefficiently. Conversely, if the teacher knows of each different behavior, these can be taught, and the learning process made less tedious, less time consuming. The data we have collected with comparable experimental and control groups of students support this affirmation. With the slides and audio tape used, for example, time spent in the laboratory to acquire a reasonable technique is cut in half, approximately, giving the student more time to learn chemistry and with less distracting worry about his own technique. The same applies to other introductory laboratory practice, from our experience, including the determination of molecular weight, use of the centrifuge, filtering, operation of a pH meter, and so on. Consider for example, the entry to exit path for a student who ultimately is to use a pure substance as a primary standard, weigh it, compare it to a secondary standard, and then use the secondary standard in a titer comparison with a solution of unknown concentration, eventually calculating a percent composition. From this entry to exit there are well over 150 different, explicit, behaviors, each of which must be mastered by the student if he is to do well. None of these are chemical, if we add them in also, the number of different behaviors is even larger, of course.

That is, explicit behavioral objectives are mandatory for the teacher. Their picayune detail at the same time tends to make them obnoxious to the student, even though they are necessary for him also. (The system shapes the objectives.) We solve the problem by attempting to be aware of the specifics and to disclose them to the student as information for use, rather than as specifics to be mastered. This makes it fairly straightforward when designed into a multi-media format, in which the broad objectives are included for student use.

To summarize, for students who wish to know what they are expected to master, broad behavioral objectives, which can be tested in a variety of ways, are useful (with an occasional incorporation of explicit, almost memorize only, objectives). But for the teacher, it is essential that the path from entry to exit be explicitly described in behavioral objective statements, which are rarely disclosed to the student, in order to plan the teaching strategy to be used. Unless we know explicitly what we propose to teach, then some of the details are only presentable in an unconscious, unaware, manner. As an example of this, consider the popular fallacy that logarithms must be taught before pH is mentioned. Depending upon the exit behavior desired, this is not necessarily true.

Introductory Chemistry 111 — A Mother of Innovation

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Presented to the General Chemistry Section, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 8, 1973.

In the Quebec educational system, the prerequisite course to the CEGEP or general chemistry courses (101 and 201) is Chem Study. Most of the students entering into Anglophone CEGEP's do not possess this prerequisite, since most high schools offer chemistry programs other than Chem Study. Therefore, they are required to take the Introductory General Chemistry 111 course. This course consists of 45 hrs. theory and 30 hrs. laboratory over a period of 15 weeks. Although the course content is specified (Table I) by the Department of Education, there is a great measure of freedom for local interpretation and adoption.

TABLE I

COURSE CONTENT OF GENERAL CHEMISTRY 111

(A) CAHIER DESCRIPTION:

La maitière. - L'atome: Mole d'atomes (atome-gr). Mole de molécules (molé-gr).

Poids atomique. - Les phases de la matière. La phase gazause. Lois fondamentales de la chimie. Classification atomique. Formation de composés: nomenclature: Notions de valence. Liaisons: ionique (notion de base), covalente (notion de base). Réactions chimiques: Classification des réactions. Energie d'une réaction. Notion de solution: unités de concentration.

(3) DETAILED DESCRIPTION:

Unit I: PROPERTIES OF MATTER: (3 hours)

Observation, measurement, reporting, types of (physical, chemical, specific, intensive, extensive), relationship between (direct and inverse proportionality, graphs and constants).

Unit II: GASES: (6 hours)

Pressure of a gas and its measurement
PV = nRT, units of PV and R
Reduced forms of general gas law: Boyle's Law, Charles' Law, etc.
Kinetic theory postulates
Average energy and velocity of particles, diffusion and Graham's Law
Mole fraction, partial pressure and Dalton's Law of partial pressure

Unit III: ATOMS, MOLECULES AND IONS: (9 hours)

Atoms: simplified structure of isotopes and atomic mass
Ions: formation of ionic bond, ionic compounds, empiric formula, ionization in aqueous solutions
Molecules: G [illegible] ac's Law, Avogadro' ypothesis, m[illegible] e, covalent bond, m[illegible] cular formula, molecular structure ar[illegible] e, molecular mass, percentage composition and molecular formula determination
Chemical equation: balancing by trial and error and oxidation number method, types of reactions, naming of compounds

Unit IV: SOME CHEMICAL PROCESSES AND CHEMICAL CALCULATIONS: (6 hours)

Description of some important chemical processes pertinent to the chemical industry and pollution. Stoichiometry involving mass, mole, molarity and volume of a g[illegible], etc.

Unit V: ENERGETICS: (9 hours)

Heat energy and matter: melting and cooling curves, joules, specific heat, heats of fusion etc., third law of thermodynamics, calorimetry; constant volume calorimeter and constant pressure calorimeter
Chemical processes and enthalpy
Internal energy and mechanical work
Determination of heats of reactions, using standard tables and Hess's law
Criteria for probable processes: changes to high entropy and lower enthalpy conditions
Probable processes: Gibb's equation, significance of predicting the temperature conditions of a probable process using thermodynamic data

Unit VI: CHEMICAL KINETICS: (3 hours)

Threshold energy, rate of a process, factors controlling the rate of a reaction, collision theory, potential energy curves, mechanism of a reaction and rate equations

Unit VII: CHEMICAL EQUILIBRIUM: (4 hours)

Recognition and explanation of equilibrium, equilibrium constant, dissociation constant of weak acids and bases, pH, Le Chatelier's principle

At Dawson College we took this opportunity to be innovative in a curriculum development way. The following check list of questions was prepared to indicate that which the student should be able to answer after successful completion of the course:

Why/(How) do processes take place?
What is the energy change in a given process?
How the mass changes, from products to reactants, and are related?
How the amount and rate of production of the products can be varied?

With these questions and the content of high school and college chemistry, biology and physics courses and the motivational problems in mind the detailed course content given in Table I was chosen for this course.

The treatment of thermodynamics is elementary and introduces the student to the basic laws. The approach highlights an inductive jump from experimental facts to non-mathematical conclusions. Such a jump was first suggested by Professor H.A. Bent (1) who further believed that this "can be initiated early in high school or freshman chemistry, yet continued without a break in strategy through the sophomore, junior, senior and graduate years if desired". Our experiment with it at this stage can be termed as encouraging. Comments like, "111 course is not what they expected it to be" (most considered it to be a make up course) and "they enjoyed the thermodynamics part the most" were commonly heard when the students were asked to comment on the course content. Discussion of entropy caught the imagination of several students.

In the winter term the course was given in a mixed mode of lecture and modular system, to a group of 48 students. The results are shown in Table II. For comparison, the results of another group of 56 students who took the same course (lecture method only) during the Fall '72 term are also shown. While any definite conclusions from these results could be stretching the point at this stage, it is however noteworthy that about 40% of the repeaters did well in the mixed mode system and that among the students registering for the first time nobody failed in the mixed mode system. Students in lecture mode used a text book. Students in mixed mode used prepared notes. Since the prepared notes specifies the course content and skills to be mastered, students favoured mixed mode to lecture system.

MOTIVATIONAL PROBLEMS

Students generally have a preconceived idea that 111 course is a make up course and tend to procrastinate. The first lecture was devoted to point out to the students the differences in 111 and high school course content, depth of treatment and topics emphasized. A pre-test based on the 111 course content was also found to be useful to drive the point home.

SUMMARY AND CONCLUSIONS

From my teaching experience at University, College and High School level, I recall that most students are eager to know WHY? Although in science this question is answered in terms of HOW, it should have a place in a first science course that the high school student encounters.

What subject other than chemistry is best suited to introduce the student to this topic through the laws of thermodynamics? Although our experimentation is on a course designed to meet the so called "inadequate situation" in our high schools, the response of the students to the course content is adequate enough to call for further experimentation, with first chemistry course content to include the laws of thermodynamics. Students at this stage find relating the laws of thermodynamics to experiences in real life easier than relating the atomic orbitals to the spectra that they have not even observed.

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TABLE II

ANALYSIS OF STUDENT PERFORMANCE

WINTER 72-73

NUMBER OF STUDENTS REGISTERED - WINTER 1972-73
(MIXED MODE)

48

26 (REGULAR STUDENTS) — GRADES (RAW SCORE)

(100-90) A	(89-80) B	(79-70) C	(69-60) D	FAIL
3	6	11	6	0

22 (REPEATERS) — GRADES (RAW SCORE)

(100-90) A	(89-80) B	(79-70) C	(69-60) D	FAIL
1	1	7	8	

FALL 72-73

NUMBER OF STUDENTS REGISTERED - FALL 1972-73
(LECTURE STYLE)

56

GRADES (RAW SCORE)

(100-90) A	(89-80) B	(79-70) C	(69-60) D	FAIL
9	17	12	7	11

NOTE: The number students mentioned here are the numbers registered in the author's sections. Over 300 students followed the same course content in other sections.

BONDED SOUL

Thermodynamically speaking, this event was long due as a happening. In spite of the spontaneous desire, lethargy kept entropy changes in the past to a minimum. Thanks to heat and a catalyst, they helped in getting out of low energy state and riding that activation energy hump to the product. The rate of change in entropy in the beginning was high and decreased steadily to zero as the present equilibrium position is reached. A macroscopic state at equilibrium looks quiet, but a wise man who is worth his pandom thoughts recognizes that changes at microscopic state never cease in reality. Human beings that we are, are neither isolated nor closed systems and synthesize choas causing order. Open criticism does lead to change in constraints and eventually to all efficient process. Then the dilemma is "Is it our duty to create pockets of order in an universe of ever increasing choas or seek comfort in the realization that the rules of the game are you can't win, or break even or get out alive."

S. Vadlamudy

Le Programme De Techniques De Genie Chimique — Objectifs Et Contenus

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Presented (in French) to the Chemical Technology Section, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 8, 1973.

INTRODUCTION

Dans la fabrication d'un produit chimique, on distingue deux fonctions importantes: premièrement, la détermination de la qualité de le matière en différents endroits de son cheminement dans le processus de fabrication; deuxièmement, le maintien des différentes opérations physiques et chimiques que doit subir cette même matière pour passer de l'état de matière première à celui de produit fini.

Sans prétendre que chacune de ces fonctions doit appartenir exclusivement à un type de technicien ou technologue, il est logique de concevoir des programmes orientés plus spécifiquement vers l'accomplissement efficace de l'une ou l'autre de ces deux fonctions.

Le programme de formation de technique de chimie industrielle d'avant 1965 a reflété la prépondérance de chimistes parmi les responsables du programme. En effet, l'emphase était mise sur les techniques de laboratoire principalement les techniques analytiques.

C'est à la suite de consultations auprès des cadres techniques impliqués dans la production et l'amélioration des procédés de fabrication que le département de chimie de l'Institut de Technologie de Jonquière (aujourd'hui Cégep de Jonquière) a décidé d'offrir un programme de formation accordant plus d'importance aux opérations physiques rencontrés dans la fabrication d'un produit chimique, soit les opérations fondamentales du génie chimique.

Au cours de cet exposé j'ai l'intention de vous présenter les objectifs de ce programme, les cours propres à ce programme, et finalement mon point de vue sur des modifications éventuelles de ce programme.

CORPS

(a) Objectifs du programme et comparaison avec celui de Technique de Chimie Analytique.

On peut considérer les objectifs du programme sous deux aspects: l'aspect connaissances à acquérir et l'aspect tâches à accomplir.

1. Sous le premier aspect, le programme a pour but d'-ssurer une bonne formation generale en prevoyant des cours de langue et litterature, de philosophie, d'education physique. Il tend à donner de solides connaissances de bas: en physique, en mathématiques ainsi que dans les différentes disciplines de la chimie. Une importance particulière est accordée à l'étude des principes fondamentaux et des techniques utilisées dans les principales opérations fondamentales recontrées dans l'industrie chimique: l'écoulement des fluides, la transmission de chaleur, l'évaporation, l'extraction, la distillation, etc. L'étude des principales industries minérales et organiques ainsi que du contrôle automatique des procédés complète ces objectifs.

Le programme de techniques de chimie analytique prévoit la même formation générale et l'acquisition des mêmes connaissances fondamentales. Dans ce programme toutefois, une plus grande imp-rtance est accordée à la conaissance des principes et des techniques de l'analyse chimique tant par voie humide que par voie instrumentale.

2. Sous le deuxième aspect, le programme vise à former un technologue capable de travailler à la mise au point de nouvelles méthodes de production, à l'amélioration des méthodes existantes de production, à la solution des troubles mineurs pouvant survenir dans le fonctionnement des appareils de production, et capable de rédiger des rapports techniques. Le programme de techniques de chimie analytique comporte des objectifs opérationnels analogues mais liés aux travaux de laboratoire d'analyse et de recherche.

Vous avez en mains la grille du programme de techniques de génie chimique. Il est bon de noter que tous les cours des deux premières sessions sont communs aux deux programmes, que ceux des troisième et quatrième sessions sont également communs sauf pour un cours: en effet en génie chimique, on trouve un cours d'opérations fondamentales qui est remplacé dans le programme de chimie analytique par un cours de chimie analytique. Tous les cours des cinquième et sixième sessions sont toutefois complètement différents.

Disons, en terminant cette partie que les responsables de ces deux programmes ont voulu quand même leur conserver une certaine polyvalence pouvant permettre aux gradués de l'un ou l'autre programme de pouvoir travailler, après un court entrainement, efficacement dans le domaine de l'analyse ou de la production et autres qui leur sont reliés comme le contrôle de la pollution.

(b) COURS PROPRES AU PROGRAMME DE TECHNIQUE DE GENIE CHIMIQUE

Les quatre cours de programme qui lui sont vraiment spécifiques sont: Opérations fondamentales, Techniques Chimiques Industrielles, Contrôle des procédés, et Chimie Instrumentale.

1. Opérations Fondamentales:

Ce cours reparti sur qua re sessions se divise:

en Opérations Fondamentales I: c'est un cours de stoechiométrie industrielle et de mathématiques graphiques appliquées à l'industrie chimique. Il permet à l'étudiant d'aborder logiquement les problemes techniques qui se présentaront à lui dans l'industrie.

en Opérations Fondamentales II, III, et IV: Dans ces parties, on présente la description et le fonctionnement des appareils dans lesquels se déroulent les opérations fondamentales de l'écoulement des fluides, de le transmission de chaleur, de la filtration, de la distillation et autres, ainsi que les lois physico-chimiques fondamentales régissant ces operations. L'étudiant est appelé à réaliser des schémas d'appareil ou de partie d'appareil et à résoudre des problèmes simples reliés à ces opérations.

Les travaux de laboratoire permettent à l'étudiant d'opérer des appareils d'échelle semi-industrielle et de présenter des travaux personnels d'évaluation de ces appareils. On a équipé notre laboratoire avec des appareils en verre pour permettre une observation plus facile des phénomènes étudiés. Une grande importance est accordée à la facon de compiler les données et de présenter les résultats dans des rapports techniques.

2. Techniques Chimiques Industrielles:

Ce cours réparti sur deux sessions comprend:

Techniques minérales: Ce cours permet à l'étudiant de connaître les principales industries minérales du pays ainsi que les problèmes de pollution reliés à leur opération. Des visites industrielles et des travaux de recherche bibliographique sont intégrés à ce cour.

Techniques organiques: Ce cours permet à l'étudiant de connaître les principales industries organiques du pays ainsi que les problèmes de pollution reliés à leur opération. Des travaux de recherche bibliographique permettent aux étudiants d'apprendre à se renseigner et à présenter des exposés.

3. Contrôle des Procédés

Ce cours est donné en dernière session et permet à l'étudiant de connaître les méthodes de mesure et de contrôle des variables dans les procédés chimiques ainsi que l'appareillage instrumental utilisé dans ces méthodes. Nous croyons que ce cours est essentiel pour comprendre ce qui se passe dans l'industrie chimique qui devient de plus en plus automatisée.

4. Chimie Instrumentale

Ce cours est principalement une initiation aux méthodes analytiques instrumentales utilisées pour le contrôle "in process" de la qualité des matières dans les différentes étapes d'une fabrication. Des travaux d'analyse à l'aide des appareils de laboratoire permettent de saisir les principes de fonctionnement de ces méthodes.

(c) MODIFICATIONS EVENTUELLES

Conscients de l'importance d'une part de répondre aux besoins de l'industrie et d'autre part d'assurer une formation polyvalente qui permette à nos gradués d'avoir accès au plus grand nombre d'emplois possible, voici quelques changements que nous pensons apporter éventuellement au programme actuel.

1. Stages: Nous espérons incorporer à l'intérieur du cours de techniques chimiques industrielles des stages pour saucer l'étudiant pendant quelque temps dans l'atmosphère d'une usine. Nous entrevoyons toutefois deux problèmes à résoudre: trouver des industries qui accepteront de participer à une telle expérience, et organiser l'occupation de l'étudiant durant son stage. Ca se fait dans certains secteurs, ca devrait pouvoir se faire dans le nôtre.

2. Sciences Graphiques: A date nous avons intégré les notions de sciences graphiques à l'intérieur du cours d'opérations fondamentales avec un succèss plutôt mitigé. Nous pensons devoir revenir à un cours de dessin industriel mais appliqué à l'industrie chimique.

3. Spécialisation Tardive: Nous nous demandons s'il ne serait pas préférable de conserver complètement communes les quatre premières sessions et de ne spécialiser qu'en cinquième et sixième sessions. Ceci permettrait de conserver aux deux programmes la polyvalence mentionnée plus tôt.

Toutes ces modifications seront prises en sérieuse considération dans le cas d'une refonte éventuelle du régime pédagogique actuellement en vigueur dans les Cégeps du Québec.

CONCLUSION

En terminant j'ose exprimer le souhait que les remarques énoncées au cours de cet exposé sauront susciter chez plusieurs d'entre vous des points d'interrogation et des points de vue que vous ferez valoir au cours de la discussion qui suivra tantôt.

Chemistry Programs and Objectives of the USA Community Colleges

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Presented at the Symposium on Organizational Strategies for Achieving the College Objectives through the Chemistry Programs of the Canadian and the USA Community Colleges, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 7, 1973

In the United States the term Community College is used to include institutions of various types. These institutions may be described best as two-year colleges since their programs require a completion of at most two years of instruction. Included are the public community and junior colleges the private junior colleges; the technical institutes; and the two-year centers of the universities. The majority of the two-year colleges in the USA are open-door comprehensive community colleges.

The "Open Door" means that college entry is unrestricted. It may mean that the student can be admitted without having achieved a high school diploma. It means that a variety of courses and curricula are available at different levels to satisfy a wide range of student abilities and interests. It does not mean that a student may choose those courses which clearly are beyond his ability.

Six educational purposes are generally recognized as objectives for a "comprehensive" institution. These are: (1) transfer or university parallel education; (2) occupational or career education; (3) general education: (4) counselling guidance; (5) community service; and (6) remedial education.

The public two-year colleges may be partially or completed governed by local authorities. Considerable financial support is received from local sources. Tuition is relatively low in comparison to other institutions of higher education, and in some cases non-existent. Classes are scheduled for the convenience of students in late afternoon, evening, Saturday, and in some institutions on Sundays and at all hours of the day and night. Education and training are available for all members of a community regardless of age.

In satisfying the need for "transfer education" the college provides a complete lower-division college program for those students who plan to complete the four or five year programs in the traditional academic and professional disciplines.

The two-year college offers an opportunity for those students, who do not initially meet the entrance requirements for the university, to demonstrate their ability to achieve an acceptable level of achievement in college-parallel courses and transfer as juniors to the four-year institution to complete the requirements for a baccalaurate and often [illegible] graduate degrees. Many students eligible to enter the [illegible] year institution upon high school graduation choose to e[illegible] in the two-year college and then transfer.

A Chemistry transfer curriculum in a two-year college usually consists of a two semester general college chemistry course in the first year and a two semester organic chemistry course in the second year. These courses are equivalent to those offered on the corresponding level of the four-year college or university. Some programs include a course in quantitative or instrumental analysis in the second year. The Committee on Professional Training of the American Chemical Society has published Guidelines for Programs in the Two-Year Colleges. This statement provides a guide for the two year college in determining the type and level of chemistry courses for the well prepared and the underprepared student desiring to obtain two years of college level chemistry.

Occupational or career education prepares students for employment after completing two years of study. The chemical technician curriculum is an example of this type of program. The Chemical Technician Curriculum Project of the American Chemical Society supported by the National Science Foundation has generated a series of texts for a suggested course of study. To serve the needs of other occupational groups such as nursing, inhalation therapy and other health occupations, fire science, engineering technology, etc. separate courses are often designed for each curriculum.

General education includes chemistry courses or integrated physical science or natural sciences courses provided for the non-science student.

As a result of relatively small classes in many two-year institutions and the introduction of various types of individualized instruction the chemistry instructor in these colleges assumes an important function in counselling and guiding students desiring to achieve many different goals. In cases where the primary objective may be unrealistic the student in a two-year college can often be convinced to pursue his career on a related level better suited to his abilities.

Community service offers the two-year college the opportunity to serve the specialized or general needs of the community by providing educational programs such as lecture series on current topics of interest. Many two-year college chemistry departments have yet to fully develop programs of this type.

For those students entering the two-year college deficient in mathematics, chemistry or other skills required for success in a general college chemistry course, remedial courses are provided. Many two-year colleges provide a one-semester preparatory or remedial chemistry course for these students.

The programs of two-year education described above is characteristic of the majority of the community college in the United States. The administrative organization of the sciences within a college will depend upon the size of the component programs and the preferen[illegible] the institution. The typical case in the USA finds chem[illegible] a part of a science division composed of the physic[illegible] sciences, sometimes including mathematics or of the natural sciences. [illegible]n large colleges chemistry may be a separate department. The achievement of the objectives of chemistry instruction depends on the quality and dedication of the chemistry staff [illegible] administrative unit performs its function of furnishing necessary materials and facilities. Excellent chemistry programs can be found in each type of science unit.

The major problems faced by a two-year college offering a chemistry program are the expense of the program and the articulation of the program with neighboring four-year institutions. Small enrollments in beginning chemistry courses sometimes affect the ability of a college to offer a diversity of courses to satisfy the varied needs of its students. For example, 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 may not have the staff or students to offer an organic course in the second year.

If a two-year college offers a two-year chemistry transfer program, the major problem is one of articulation with the four-year programs in its immediate area of state. Proper coordination of programs results in the chemistry student being prepared in his junior year to begin the study of physical chemistry and to make a smooth transition to the four-year institution. 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 so that the difference in course content between different institutions will be minimized.

In the larger USA community colleges, chemistry students are able to obtain a well-balanced program in mathematics, physics, and two-years of college level chemistry including one year of organic chemistry and have few problems in pursuing and completing a Bachelor of Science degree in chemistry within two years after graduation from the two-year college.

Chemistry in the Community Colleges in British Columbia

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There are nine community colleges in British Columbia, all of which began during the last nine years. Vancouver City College which was the first to open in 1965, is the largest with over 4,000 students. There are two other colleges close to Vancouver; Capilano which began in 1968 and Douglas which opened in 1970. These three colleges are within commuting distance of two of the province's universities - the University of British Columbia and Simon Fraser University. The newest college is Camosun (1972), situated near the third provincial university, the University of Victoria, on Vancouver Island. The remaining five colleges are in less populated areas of British Columbia. Selkirk which opened in 1966 and College of New Caledonia which opened in 1969, are the smallest colleges serving the Kootenay and Prince George regions respectively. Malaspina College at Nanaimo, 90 miles north of Victoria opened in 1969 and Cariboo College at Kamloops opened in 1970. Okanagan College opened in 1968 with three centres in communities in the Okanagan Valley. The other multi-campus college is Douglas, which has centres in three adjoining municipalities on the outskirts of Vancouver.

The colleges function autonomously under the Public Schools Act of British Columbia, administered by the Post Secondary Division of the Department of Education. College Councils act as governing boards for their own college and council members are appointed three different ways.

1. A variable number of elected school board members from each school board within the college district - appointed by the school boards
2. One school superintendent from a school board within the college district - appointed by the Minister of Education.
3. A variable number of representatives from the community- appointed by the Lieutenant Governor of the province in Council.

Capital costs are 100% provincially funded and operating costs are shared 60% - 40% between the provincial government and the school boards within the college district.

All the colleges offer academic transfer courses which enable students to complete the first and second years of a regular university program, and one or two year career programs which are designed to prepare students for employment in business and industry. A number of career programs, such as Business Management, Medical Laboratory Technology, and Electricity and Electronics have first year transfer status to the British Columbia Institute of Technology. All but two (Capilano and Douglas) of the colleges have recently been melded with their local vocational schools. Each college region is a different community and this is reflected in differing objectives and offerings but the main objective is to serve the community. Entrance requirements do vary between colleges, however, all have an "open door" policy and high school graduation is not an entrance requirement. All members of the community are encouraged to attend as a regular student or at smaller, non-credit community service courses.

Although each college is autonomous the types and levels of courses are governed to a degree by external factors. In the case of university transfer courses this external factor is acceptance of the courses by the universities of the province. Transfer credit is negotiated independently at the department level between each college and each university for every course. The system may be ponderous, but it seems to have a number of advantages.

1. The negotiation is at the department level and this encourages college-university liasion. Transfer credit need only be negotiated once and when granted remains unless the college initiates a major change in the course. Final transfer credit authority remains with the university registrars and detailed transfer credit guides for each college are readily available.

2. Articulation meetings in each subject are held at least once a year. These meetings were initially for clarifying any problems of transferability but as these problems get settled, the articulation meetings are concentrating more on future planning and professional development.

3. Universities can (and do) inform the colleges ahead of time on proposed course changes and request college input.

4. The system allows for variation between the colleges and universities without handicapping students. Courses may get assigned credit where the college course is very similar to the university course, unassigned subject credit where the college course differs considerably from the university course or unassigned general credit where the college course cannot be assigned to any of the university departments.

There is no official standard series of science courses but most colleges offer two levels at the first year; one for students planning to major in science who have had the appropriate grade 11 or grade 12 course and the other for the student who needs one or two science courses towards some other degree or who has had no previous experience in the subject. Most science courses include a laboratory section. Laboratory instructors as well as science faculty are involved in laboratory teaching. As many of the new colleges are operating out of temporary, portable and makeshift facilities, laboratory space and equipment is sometimes barely adequate but planning has already started for permanent buildings and this problem should eventually be solved.

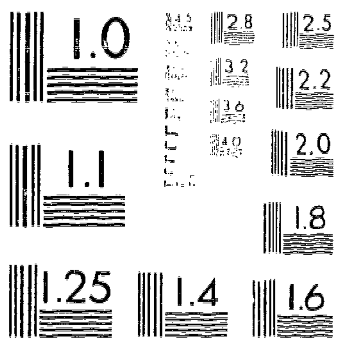
The Chemistry courses at Capilano College are typical of chemistry courses in community colleges in British Columbia. Two first year chemistry courses are offered:

1. A non-major course, specifically designed for non-science students, which also fulfills the first year chemistry requirement for nursing, home economics and physical education. No previous chemistry or mathematics is required. Although this course is not designed for chemistry majors, it is not a terminal course and can lead to 2nd year chemistry courses and then to such 3rd year courses as the University of British Columbia's Bio-Inorganic Chemistry and the 4th year Bio-Physical course..

2. A course for students who plan careers in science. This course is a requirement for majors and honors in Chemistry and for students planning to enter engineering school. Recommended for medicine, dentistry, forestry, agriculture and pharmacy although the lower level course will satisfy the requirements of these areas. Chemistry 11 or 12 and Mathematics 12 are prerequisites for this course and college level calculus must be taken concurrently.

From these course descriptions, it may appear that students who have no previous chemistry when they enter college, are unable to major in the subject, however this is not the case. The college and university requirements are written so as to encourage prospective chemistry majors to start their chemistry studies in high school, but a good student in the non-major course can switch to a majors or honors program at the 2nd year level with departmental permission. For the colleges this means the instructor writing a letter to the university department concerned, is recommending that the student be allowed to enter the majors or honors stream. This informal arrangement is working well, although very few students are in this category.

Capilano College offers two second year chemistry courses; organic and physical-inorganic. There are no transfer problems with organic chemistry, but as the University of British Columbia has very different physical-inorganic courses for chemistry majors and non-majors at the second year, problems do arise. The second year physical-inorganic chemistry course for chemistry majors at the University of British Columbia consists of quantum mechanics and coordination chemistry. The non-majors course consists of thermodynamics and inorganic chemistry and is slanted towards the biological sciences. Capilano College (and most of the other colleges) offers this latter "Physical Inorganic Chemistry for the Life Science" course, which as a requirement for medicine, dentistry, pharmacy and many areas of biology is in greater demand than a specialized course for chemistry majors. Consequently, the curriculum does not encourage a chemistry major to remain at the community college for a second year and most chemistry majors transfer to uni-



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

versity at the end of the first year. This problem will no doubt be solved, when the student population of the colleges is large enough to support both types of second year physical-inorganic chemistry courses.

A community college requires permission from the Department of Education before any new career program is started. This is to prevent unnecessary duplication of specialized programs at neighboring colleges and to ensure availability of adequate facilities, faculty and job opportunities for graduates. Some examples of career programs in which science faculty are involved or will be involved when the program starts are:

Electricity and Electronics
Construction, Technology, Materials
Science Recycling; Water and Waste
Water Treatment, Medical Laboratory
Tech, Chemical Laboratory Lab Tech.
Photography, Nursing, Horticulture, Food Preparation

Some science faculty also teach in general studies programs and in multi-disciplinary courses. Chemistry faculty in the British Columbia community colleges agree that one major problem exists; lack of time. This includes time to develop professionally in the field of chemistry, time for travel to libraries, laboratories, seminars and university facilities, especially for the more remote colleges, time needed to read chemical and scientific publications, time to revise, update and improve courses and laboratory experiments and time to attend the many meetings and participate in the many committees that seem to be an integral part of community college life.

Chemistry in the Junior Division of the Memorial University of Newfoundland

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Presented at the Symposium on Organizational Strategies For Achieveing the College Objectives Through The Chemistry Programs of the Canadian and the USA Community Colleges, the Thirty-Fifth Two-Year College Chemistry Conference, College Ahuntsic, Montreal, Quebec, Canada, June 7, 1973

The college system as exemplified by CEGEP, CAATS, and others has not yet emerged in Newfoundland. The provincial government recently committed itself to the establishment of a "regional junior college" in Corner Brook, our second largest city, within the next year and a number of "community colleges" in key locations were to follow. At this stage the only action taking place is some rather lively debate as to what type of system the first college should be. The University, in assuming that at least one part of it will function as a branch of the St. John's campus, has been making its own plans and actively considering the issue of what curricula and programs will best meet the needs of the people in the area. One of the reasons given for the creation of the Junior Division in 1968, which presently includes all first year instruction, was to serve as a prototype for the first regional college. In other words, it would serve as a testing ground where structures and programs would evolve that could then be transferred to the new locality as a two-year college.

Other post-secondary institutions in the province take the form of vocational schools, a College of Trades and Technology, and a College of Fisheries and Marine Navigation. They operate separately from the high schools and offer a wide variety of occupational-based programs that lead to specialist certificates and diplomas.

Memorial University is the only university institution in this province and as such is perhaps more of a "community university" than many of its counterparts in other provinces of Canada. I suspect that it serves a population of more diverse backgrounds than many other Canadian universities. Through its extension and off-campus services it is able to provide a varied program to the major centers of the province located off the Avalon Peninsula (that part of the province comprising slightly more than half the population which is not within commuting distance of the University).

Memorial University has experienced a period of very rapid growth from a campus consisting of a single building enrolling 300 students in 1950 to a complex system now serving some 11,000 students with medical, engineering, and education schools included. The University is financed primarily from public funds through a grant from the provincial government. Apart from deciding what its annual grant will be, the government allows the University to function as an autonomous entity directed by a Board of Regents. Students averaging in age from 17-18 enter Memorial upon successful completion of Grade XI with Junior Matriculation standing, and these would be expected to graduate with a bachelor's degree after four years of study. Bridging the gap between high school and university is the major challenge facing Memorial University, and the approach being taken to solve this problem is the basic theme of the paper.

As memtioned above, the Junior Division came about in response to a need for a diversified first year program that would assist students in their transition into university, that would provide a foundation for underprepared students, and that, in general, would improve a student's chance of success. The need of such a program for chemistry students, in particular, will be demonstrated and the evolution of a three-tract system will be described. None of the first year courses in the major subject areas are terminal, and a pass permits entry into the next course at the second year level.

The Chemistry courses offered at Memorial are typical of those offered at most Canadian universities except perhaps in the case of the Foundation Chemistry course (Chem 100F). It is a one-semester, non-credit course that covers the "basics" considered as pre-requisite to the start of study in the regular courses. The materials for our first year courses are drawn from a variety of sources including the Chem Study materials, Nuffield "0" and "A" level Chemistry books, the Masterton and Slowinski package, and a number of problem and programmed tests at that level. The total chemistry enrollment that fluctuates between 600-800 is taught in class sizes averaging 30 students by 12 faculty with support from four instructional assistants. Laboratory sessions are closely integrated with class work and faculty treat the learning experience in each with equal importance.

The biggest problem that confronted faculty teaching Chemistry at the first year level was the one of the underprepared student and the resulting high failure rate. Next to that a more fundamental problem or task is to evaluate the effects of our efforts to date, and to decide where we go from here.

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