

WRITTEN SUMMARIES FROM DISCUSSION GROUPS

1965 MACTLAC MEETING

(Group 1. ROUNDTABLE DISCUSSION was cancelled)

Group 2. THE ROLE OF MACTLAC DEPARTMENTS IN THE PREPARATION OF HIGH SCHOOL SCIENCE TEACHERS

Leader: Courtland Agre, Augsburg College

The Chairman presented much information indicating the continued low level of preparation of science teachers in elementary and secondary schools. Less than ten percent of the high school science teachers in Minnesota meet the modest minimum recommendations of the Garrett Committee Report of fifteen years ago. Statistics also showed that liberal arts colleges are producing a distressingly low number of science teachers (only about 10% of those employed in Wisconsin).

The state departments of education are slow to adopt higher requirements for certification. Because of inadequate undergraduate preparation in their science majors, high school teachers tend to do their advanced work in Education. As a consequence, high school students are ill-prepared when they enter college and the chemistry department, receiving a mediocre product from high school Chemistry, faces the problem of producing in four years a teacher who is properly qualified.

The colleges can establish the minimum requirements for the major in Chemistry, but high school teachers can be assigned to teach in fields in which they have not majored. A scarcity of qualified teachers of high school Chemistry encourages the latter situation. The colleges should seek to encourage more students to prepare for teaching Chemistry in the high schools.

But students with bright minds should be encouraged to go to graduate school. Industry, with better salaries, offers competition. As a consequence, the number of Chemistry majors who can be recruited for high school teaching is reduced. It was generally agreed that a student of average ability and who is well prepared in the field could be a good high school teacher. Personality and an ability to communicate with students were recognized as important and necessary characteristics of a good high school teacher.

In conclusion, the group concurred in stating that the college graduates in Chemistry who are to teach in the high schools should meet the minimum recommendations of the Garrett Committee. Physical Chemistry was considered to be more important than Organic Chemistry because of the Chemical Bond Approach. The student must have sufficient background so that he is able to show the impact of Chemistry upon our life and upon the age in which we live. It was also emphasized that an adequate undergraduate preparation in chemistry would permit the teacher to pursue graduate work in the discipline rather than in education.

Group 3. RESEARCH SEMINAR IN COORDINATION CHEMISTRY

Leader: William Deskin, Cornell College

Reports of recent research investigations were presented by four MACTLAC members. (A more detailed summary of the talks is on file with the proceedings of the meeting.)

(OVER)

Group 3. (continued)

I. Sister M. Kennelly of Mundelein College reported on a study of the infrared spectra of metal complexes of amino acids. Study of the NH_2 stretching frequency (using the sodium salt of the amino acid as a standard) showed that it appears at lower frequencies as the acid is complexed. The C=O stretching frequency for the complexed acids was in the range $1590\text{-}1660\text{ cm}^{-1}$.

II. Dr. T. Donovan of Knox College reported structural studies of $\text{Na}_3[\text{Co}(\text{CO}_3)_3] \cdot 3\text{H}_2\text{O}$. Although a useful starting reagent for synthesis of other cobalt (III) complexes, its structure is uncertain. Comparison of the IR spectra of this compound and other carbonate complexes with the calculated bands for unidentate and bidentate carbonate indicated that the carbonate is a unidentate in this compound.

III. Dr. D. Tarr of St. Olaf College reported a study of the iron (III) complexes of benzohydroxamic acid. Stability constants for the 1:1 complex from spectrophotometric studies were reported on the pH range 0 to 2.

IV. Dr. R. Rich of Bethel College reported the preparation of a very stable complex of copper, prepared from diacetyl pyridine, copper acetate and 1,3-diaminopropane in DMF. The complex is diamagnetic as a solid and paramagnetic in solution.

Group 4. THE COMBINED INTRODUCTORY COURSE IN CHEMISTRY AND PHYSICS.

Leader: William Child, Carleton College

In an opening statement Dr. Child of Carleton College called attention to the reasons for the combined introductory chemistry-physics courses and posed the following questions:

1. Do students understand and appreciate the reasons for the course?
2. What is the role of the course in respect to non-science students?

He then asked Dr. Ralph Deal of Kalamazoo College and Dr. Edward Fuller of Beloit College to describe the combined programs in their respective schools. Their reports served as a basis for the ensuing discussion which, at first, consisted largely of questions to them and their answers. By the end of the meeting several more or less well defined ideas and impressions were apparent, and we summarize them in outline form.

AIMS - the combined programs seek to:

1. take advantage of the basic principles, normally first taught in physics courses, which are useful to chemistry,
2. show the underlying unity of chemistry and physics,
3. avoid duplication of material.

ADVANTAGES AND GAINS of the combined program are:

1. there is a definite saving of time,
2. chemistry students come earlier to understand the basic physical-chemical concepts and relations (for example, energy),
3. the student generally is more knowledgeable and better prepared for subsequent courses.

Group 4. (continued)

DISADVANTAGES AND PROBLEMS result from:

1. a lack of suitable textbooks,
2. a lack of teachers who have training in both chemistry and physics. As a result the courses usually are broken up into periods taught alternately by chemistry and physics teachers and hence lose some of the desired unity.
3. the difference in terminology and symbols as used by physicists and chemists.

OUTLOOK:

1. More suitable textbooks are forthcoming.
2. The number of properly qualified teachers will probably remain small.
3. The place of the non-science student in the program remains unclear.
4. Combined programs at the higher levels can be expected.

Group 5. INSTRUMENTATION REQUIREMENTS IN THE UNDERGRADUATE CHEMISTRY CURRICULUM.

Leader: Richard Bayer, Carroll College and John Zimmerman, Wabash College

The discussion began with a report of an informal survey conducted by the group leader. Of the 22 schools comprising the survey:

1. All schools had gas chromatographic, UV and IR instrumentation.
2. Most schools had at least two recorders.
3. Two schools had an NMR and four had a Cary 15 or a Beckman DK spectrophotometer.
4. Thirteen of the 22 schools surveyed were seriously interested in NMR.

The ensuing discussion developed around the criteria involved in the addition of instrumentation to a department's curriculum. Cost did not appear to be the decisive factor. The group noted an increasing willingness of college administrations to purchase costly instrumentation. This observation was especially true when matching fund arrangements could be made.

The next criterion to be considered was the question, "How much instrumentation is essential to the undergraduate curriculum?" The main point of contention was the advisability of purchasing an NMR. This led to a discussion of the effectiveness of an elementary organic course with a spectroscopic emphasis, but without direct student contact with the instruments in question. The group was equally divided on this point. Concern was expressed for an over-emphasis on instruments at the expense of principles demonstrated by more classical approaches.

The group consensus was that the small liberal arts college could not hope to purchase and maintain an up-to-date holding in all the diverse areas of chemical instrumentation. However, the chemistry major should be exposed in depth to at least one of the more sophisticated instruments -- IR, X-ray, etc. Student experience with the maintenance, stability and calibration problems inherent in complex instrumentation was considered to be an important complement to the use of instrumental data to help answer chemical questions.

Several participants pointed out the common oversight of maintenance costs as a factor in instrument selection. The mechanical and electronics ability necessary to maintain

Group 5. (continued)

instruments in an optimum operating condition was a missing factor in most of the departments represented. An informal show of hands indicated approximately half (20) of those present were interested in obtaining formalized electronics instruction. Several noted that heavy demand for such instruction has made it difficult to gain admittance to the various concentrated programs of instruction based on the Heathkit adaptation of the Malmstadt-Enke modular electronics approach.

Group 6. ACS APPROVAL OF UNDERGRADUATE CHEMISTRY DEPARTMENTS

Leader: Stephen Darling, Lawrence University

Resource Person: E. L. Haenisch, Wabash College

Dr. Haenisch indicated that at the present time there are over 330 approved departments and 20-25 requests for approval of new departments each year. This constitutes a preposterous working load if each approved institution is to be visited once every five years. The Committee on Professional Training is much concerned with the quality of both undergraduate and new Ph.D. programs.

At the National ACS meeting held in Atlantic City in September, 1965, the Committee met with the department heads from approved institutions and discussed various proposed changes in the minimum standards. A new edition of the Minimum Standards booklet should be out some time in December, 1965. The changes will not be very great. Many of the proposals made in Atlantic City will not be put into effect. As the Committee has stressed repeatedly in the past, it is willing to consider special proposals with an open mind.

Questions and answers indicated the following:

1. Biochemistry if offered should have an a prerequisite one year of organic and some preparation in thermodynamics and kinetics.
2. Some concern has been indicated about the 180 hours of organic laboratory. These may be reduced.
3. Qualitative organic seems to be coming integrated more and more with general organic chemistry. There is nothing wrong, however, with qualitative organic as an advanced course.
4. There will probably always be four semesters of advanced courses required, but one may be in physics or mathematics. As of now, inorganic and analytical courses with a physical chemistry prerequisite are required.
5. There may be some adjustment of the 225 hours now required in advanced laboratory. This may be moved up and 180 hours of organic laboratory may come down.
6. There seems to be a desire to abolish requirements in terms of course titles and express requirements in terms of required topics.

Group 6. (continued)

7. A reading knowledge of German and evidence of the use of it in the study of chemistry is still required. Very likely Russian will be permitted as an alternate language, but it would then have to be used in advanced chemistry courses.
8. When an institution is under consideration, the Committee will probably ask to see copies of examinations, laboratory reports, research papers, etc.
9. After a request for an evaluation visit has been sent to the Committee, it may be six months or a year before the school is visited.
10. Requests for copies of the Minimum Standards booklet should be sent to:

Mr. J. H. Howard, Secretary
Committee on Professional Training
343 State Street
Rochester, New York 14650

Group 7. APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE IN ORGANIC CHEMISTRY

Leader: John McFarland, Depauw University
Panelists: Dr. Addison Ault, Cornell College
Dr. Howard Burkett, DePauw University
Dr. Luther Erickson, Grinnell College

Dr. McFarland introduced the panelists and proposed that the principles and application of N M R in teaching and research be considered and discussed. He pointed out that while large universities have complete instrumentation and sufficient funds for maintenance, the liberal arts college finds acquisition of instruments such as N M R or the mass spectrometer difficult, if not impossible.

Dr. McFarland stated that the graduate schools are beginning to insist on a working knowledge of the principles and applications of N M R. In order that his students will not be deficient in this field, he offers an introduction to the principles and applications although his school has no N M R spectrometer. Furthermore, several elementary organic textbooks include discussions of N M R applications, so that even the undergraduate student must be acquainted with this valuable technique, even though the student may never see an N M R machine until he goes to graduate school.

Dr. Erickson summarized the principles of N M R and discussed in detail three parameters which are present in high resolution N M R spectra. There are: 1) the chemical shift; 2) spin-spin coupling; and 3) relaxation times.

Dr. Erickson described undergraduate research work which he is supervising at Grinnell. In this work the student runs the N M R spectrometer and thus gains first hand knowledge of instrumental techniques. This work involved conformational analysis studies on substituted succinic acids and anhydrides where the dihedral angle between vicinal protons varied. The variation of the spin-spin coupling constant (J) with the variation of the dihedral angle was studied. For symmetrical vicinal dihalosuccinic an-

Group 7. (continued)

hydrides, the protons are equivalent except when one was attached to C^{13} nucleus (spin = $1/2$). High resolution techniques are required for observation of the $C^{13} - H^1$ splitting, which yields proton-proton spin coupling constants. There was a variation of J when vicinal dibromo anhydride was dissolved in various solvents, but no variation for the similar dichloro compound in the same solvents. This difference in behavior was not explained.

Other experiments included investigations into the metal ion complexes of biologically significant amino acids, including histidine and glycine.

Dr. Ault qualitatively defined and described saturation, spin-spin decoupling, relaxation and the effect of nitrogen on proton signals. Saturation was described as excitation of the nuclei (protons) so that the population of those nuclei in the excited state precisely equals the population of those nuclei in the unexcited state. When this occurs, there can be no net absorption of energy by transitions between the two states, and therefore the signal will fade to zero.

Relaxation is the process of emission of the excess energy from the higher energy-state nuclei. There are two general mechanisms of relaxation: spontaneous emission (a minor factor) and emission stimulated by fluctuating magnetic fields. The fluctuating magnetic fields may be due to other magnetic nuclei (most common), to dissolved oxygen or to other paramagnetic species in solution.

Factors affecting fluctuating magnetic fields were briefly described. These include the viscosity of the solution, the intensity of the irradiation, and the concentration of the sample.

Spin-spin decoupling was described as a method which is very useful in determining the structure of complex molecules. By irradiation of the sample with a selected radio frequency, transitions between states of nuclei with the corresponding chemical shift will become very frequent. Under these conditions, neighboring nuclei which ordinarily would be split by these nuclei will now all experience an average field from them and therefore will not exhibit any splitting due to them.

Dr. Ault cited some examples to illustrate the different possible appearances of the NMR signal due to protons bonded to nitrogen. The two factors involved are the rate of exchange of the protons bonded to nitrogen and the rate of relaxation of the nitrogen nucleus which can be rapid due to its nuclear quadrupole moment.

Splitting patterns for different nuclei were described but are too detailed for inclusion in this report.

Dr. Burkett presented a discussion of an undergraduate research problem concerned with detection of restricted rotation due to preferred conformation. N,N-dimethylformamide has a limited rotation about the C-N bond in the ionic species. This decreased rotation leads to two separate peaks due to the two different environments for the non-identical methyl protons. Upon application of heat, the equilibrium is shifted to the

Group 7. (continued)

non-ionic species and only one peak become apparent.

Other experiments included student research on the decarboxylation of 2,4,6-trimethoxybenzaldehyde in 70% H_2SO_4 and 64.6% D_2SO_4 to determine the position of initial attack by the acid.

Dr. Burkett showed a series of spectra of compounds related to 3,3,3-trichloro-1-nitropropene. Variations included the 1- and 2- methyl and ethyl substituted alkenes and the corresponding alkanes.

A round table discussion of teaching N M R at the undergraduate level followed. It was the concensus of the group that it should be taught and in fact, a majority of the schools represented presently teach N M R. There was no general agreement as to the best time for teaching this during a student's undergraduate career. The time of introduction varied from sophomore year Elementary Organic Chemistry (using Roberts and Caserio's Organic Chemistry) to mid-year junior Physical Chemistry to senior year advanced Organic or Inorganic Chemistry. There was one case of teaching this material together with infrared, ultraviolet and mass spectrometry during the third term of the sophomore year when Advanced Analysis (Qualitative Organic) was offered.

The problem of justification of the purchase of an N M R machine is perhaps the main reason why most schools have no plans for acquiring an instrument at present. The initial purchase price -- about \$30,800, for Coe College's A-60A -- is the main factor. However maintenance, presumed by many to be high, has proven to be suprisingly low at Grinnell, according to Dr. Erickson. He suggested that it does, however, require that one staff member assume responsibility for maintenance.

It was concluded that N M R is a very valuable tool in teaching as well as research. Whether or not a school has an instrument, the theory and applications of N M R should be thoroughly covered. Most students will learn the subject matter better when there is an instrument available.

Group 8. THE ROLE OF ANALYTICAL CHEMISTRY IN THE UNDERGRADUATE CURRICULUM Leader: Stanley Watkins, Coe College

Dr. Watkins posed as the question for discussion, how to integrate analytical chemistry into the total chemistry curriculum. In the sense that it requires a knowledge of organic and physical chemistry it is already integrated. Content is currently being handled in several ways. It may be integrated into other courses and eliminated as a separate course, or introduced in general chemistry to be followed by a more rigorous treatment in junior or senior year as a separate course. He called on the resource persons to describe their solutions to this problem.

1) Dr. Stratton, Earlham College

In the Earlham curriculum (discussed in detail in an AC₃ report) quantitative methods and analytical techniques have been integrated into courses as needed--e.g., ionic equilibria in the course on "Ions," instrumental analytical techniques in the course on Energy. The buret is used as a tool in freshman chemistry. Second year students prepare compounds and analyze their own preps. Organic qual comes in the junior year. Further synthesis and analysis of compounds, with methods taken mostly from the literature, is done in the senior year.

Group 8. (continued)

Dr. Stratton also indicated that the University of Illinois eliminates the quant course for chemistry majors. The lab work is part of the general chemistry course. Dr. Stratton feels that students are not ready for the theory at this point. There must be a significant lecture component and carefully designed laboratory work.

2) Dr. Bixler, Lake Forest College

Expressed more of the traditional view. He feels sufficient and specific time must be devoted to analytical chemistry as a separate course. At Lake Forest qualitative analysis is taken in the junior year in the form of a rigorous course in solution equilibria. The qual scheme is an excellent way to get in descriptive chemistry. Second year students take a term of quantitative analysis with special emphasis on titration curves, introduction to absorption spectrophotometry, and the analysis of real substances and mixtures.

3) Dr. Ramette, Carleton College

All chemistry demands analysis. The declining emphasis on analytical chemistry will lead to a shortage of good analytical chemists and teachers. The Carleton curriculum includes quantitative methods at all levels of instruction. A student should develop a feeling for comparative values of several methods of analysis. In the senior year analytical chemistry is presented with a professional outlook.

In the ensuing discussion the following questions were raised and answered:

Q. How can one deal adequately with all the different and complex equilibria encountered in qualitative analysis?

A. This cannot be done in the freshman year. Do much with outside reading and individual student conferences.

Q. What "significant lecture components" should accompany quant experiments?

A. The theory of indicators, end-point detection, titration curves, comparative methods.

Q. In the semester plan, where would be a good place for the analytical course?

A. It was suggested that quant be put in the first term of the sophomore year; organic in the second term; physical chemistry in the first term of the junior year, and both physical chemistry and quant courses in the second term.

Q. How can the "cook-book" aspect of qualitative analysis be eliminated?

A. Assign simple salts at the end of the course, to be analyzed without notes or texts.

Give an unknown ion not included in the qual scheme.

Do not allow lab manuals in the lab at any time - directions are restricted to what the student can put on a 3x5 card.

Q. Is the difficulty in analytical courses merely one of nomenclature? Have we changed course names but not the content?

A. It is wrong to equate elementary quantitative analysis to analytical chemistry. New course names are more descriptive and include analytical techniques where needed.

Group 8. (continued)

Q. Is there replication of samples if quantitative analysis is done in freshman year?
A. Both "yes" and "no" answers were given.

Q. What are the advantages of including quantitative experiments in freshman year?
A. You may show that different experiments need different degrees of precision, a concept not always easy to show with the conventional quant course.

Q. What is left to be taught in advanced courses?
A. Rigorous theory of chromatography; polarography; solvent extraction; advanced equilibria. Content will depend on the particular curriculum of the department.

Q. What is the place for "Electronics for Scientists" in the chemistry curriculum?
A. It is a difficult course to teach! May be taught by the physics department and encourage chemistry majors to take it.

Q. If instruments are used at the freshman level are they just "black boxes"?
A. For the most part yes. However, at some time in the curriculum these instruments should be explained in theory.

Q. What about NMR and mass spectrometry?
A. NMR and mass spectrometers are not necessary instruments in the undergraduate college. Mass spectrometry is useful only with a high precision instrument. The basic ideas of NMR can be given and spectra from other sources can be handled and analyzed by the students.

Thanks are due to the recorders who had the difficult job of preparing these summaries:

Group 2 - Albin Erickson and John Biester

Group 3 - Duane Carr and Emmitt Jacob

Group 4 - Harold Fensick and Paul Splitstone

Group 5 - Richard Bayer

Group 6 - Kenneth Hamm and James Nichol

Group 7 - Paul Barks and Tina Schultz

Group 8 - Sister John Mark and Sister M. Emilius

