EDITORIALLY SPEAKING: Effective Teaching of Organic Chemistry

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Note

/Editor's Note/: It is most appropriate for an issue devoted mainly to the chemistry of the sixth element to begin with a sermon preached on the same text. Fortunately for the non-organic editor, the following version of Dr. Lambert's provocative discussion at the Atlantic City Meeting was available. The author once before appeared at an Atlantic City ACS Meeting with a trunkfull of brightly colored styrofoam (see this /Journal/, *34*, 217 (1957)). This time his language was equally brilliant. We enthusiastically (and gratefully!) devote this page to "Effective Teaching of Organic Chemistry."

Effective Teaching of Organic Chemistry

Throughout the country there is a stimulating ferment brewing in the teaching of organic chemistry. But the ferment consists principally of new content and the reorganizing of content: emphasis on mechanism and principles, recasting of traditional functional group reactions into more meaningful patterns of mechanistic types. I believe that the brew is being cooked in too ancient a kettle.

Subject matter revisions, mild or revolutionary, are not enough. The techniques by which the subject matter is presented to the student sadly need our attention — and the easiest technique to improve is the organic lecture.

The standard lecture system is obsolete in organic chemistry classes smaller than 125 students. Why do instructors ignore the contribution of Johann Gutenberg to chemistry? Thanks to him, we now have movable type! A few chemists can write books which are readable. Why then do we fail to use these excellent modern texts as the principal basis for our courses?

The educational waste involved in the traditional process of writing coveys of equations on a blackboard while the student frantically re-copies them incorrectly in his notebook before they are shot down by an eraser should be apparent to most of us. An old gag involves the professor who writes with this his right hand while erasing with his left; it is an old gag, but it is not funny if we are interested in

education rather than boardmanship — and that last word can be spelled in two ways.

Lecture time is too valuable to waste in outlining a textbook; yet astonishingly few instructors employ any other technique in their lectures. Perhaps it is because we tend to reserve our problem-solving capabilities for laboratory research rather than to apply a modicum of them in discovering how to teach a class of students. Two better variants can be devised.

Certainly these suggestions are too obvious to be original. They are just not widely applied. Robert Levine, in a paper describing the teaching of organic chemistry at the time of the ACS diamond jubilee (see this /Journal/, 29, 224 (1959)), quotes a letter from Professor Ray Brewster of Kansas in which he describes his use of this technique. My experience of auditing organic chemistry classes as a NSF faculty fellow in 1958, however, convinces me that there are few who use such approaches to presenting the material. In my travels to major institutions across the country, there were 37 conventional, dull lectures out of the 40 visited. If I had been a bird watcher, I could have made quite a collection: “White-chested monotones,” “addle-pated note watchers,” and “unprepared cocky-crested high fliers,” to mention a few.

If the large Noller or the large Fieser, or similar comprehensive book is used as a reference text, the lectures should be mimeographed verbatim and issued to the students at the start of the course. The students should be required to read over the lectures and do problems in advance of the lecture period. The large reference book is specifically referred to in the mimeographed lectures for expansion of points of further information on difficult areas.

What becomes of the lecture period in such a system? Even if it cannot always be transformed into a successful question-and-answer period, it can at least be a much more meaningful discussion of examples of the most difficult parts of the lecture assignment. (In the name of Gutenberg, let us not read our mimeographed lecture notes to the class! I have actually seen that done.)

Some may prefer a second variant which involves choosing a completely readable textbook, one in which all or almost all of the material will be read and studied by the student in the course of a year. A few of the many possible examples would include Cason, Geissman, Morrison and Boyd,

and English and Cassidy. The text should be not only readable but replete with problems, preferably mixed in with the material rather than at the ends of the chapters. Answers to all problems must be supplied either in the text or by the instructor. Then, if the student is issued a detailed syllabus of the text in which less important points are /labeled as such/ and the most interesting sections are underscored, we have the “Gutenberg teaching-machine” — the poor man's programmed instruction. Surely, all the elements of self-instruction, programmed instruction, are there:

Active Engagement of the Student

> He knows this section is going to be discussed, not outlined, at the next lecture and that he will be lost if he doesn't study the 8-12 readable pages in the assignment.

The System is Self-pacing

> The student can go as rapidly as he wants — and turn to other sources such as Noller, Cram, Gould, or Hine, if he is a fast man. On the other hand, an absolutely minimal list of problems is given for the slower individual to conquer.

The Material is Presented in Small Steps

> There is immediate feedback if there are enough problems after every section or series of paragraphs. Every problem has an answer. The student himself can find his own errors and determine his weaknesses. Admittedly, no text is the complete equal of a psychologically-designed, programmed instruction course, but this system comes closer than the use of most texts alone.

Now the lecture, as in the first variation, becomes a discussion section, but even more successfully because the text or syllabus has more problems. As a result the students come to class with equations, or at least ready for the instructor to pose questions. What a revolutionary experience it is to teach such a class!

The usual lecture is a desperately sad affair, viewed objectively. The instructor presents a boardful of elegantly-organized material with answers by the score, beautiful answers — to questions that the students have not asked. What is more futile than that?

In a modern “Gutenberg” lecture, things still do not work perfectly, of course. The students are not used to pre-studying before the day of the lecture. It is against all of their previous training and their other course practices. A few just do not do the work that they should, hoping to catch something from the lecture, or to regain skipped ground just before the next exam. No, of course, it does not work perfectly, but it works excellently for the A and B students. I believe that it does for the C people as well, because at all levels the student gets the feeling that here at least is a course in which he is involved. The burden for his achievement is directly and immediately on him, as he reads the text and tests himself with problems. The instructor's role is changed from that of a “high-priest of science,” droning on in endless lectures, to that of a “coach” in the highest sense — a mentor who is concerned with showing the students ways to become proficient in a new and challenging field.

Our job is to aid students to learn — not to impress them with our skill at blackboard writing. We can not do it without content — or without techniques which involved the students in the struggle to stretch their own minds.

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