

University of Maryland Interlibrary



ILLiad TN: 11733

Borrower: UNA

Lending String: *UMC,STI,VSU,SNN

Patron: Olson, Niels

Journal Title: Undergraduate education in chemistry and physics ; October 18-19, 1985 /

Volume: Issue:
Month/Year: Pages: 50-58

Article Author:

Article Title: Morrison, R. 'The lecture system in teaching science'

Imprint: [Chicago] ; College Center for Curricula

ILL Number: 2379986



Call #: EPSL Stacks QD40 .U5 1986

Location:

ARIEL

Charge

Maxcost: \$15.00IFM

Shipping Address:

Nimitz Library, ILL
United States Naval Academy
589 McNair Rd
Annapolis, MD 21402-5029

Fax:

Ariel: 131.122.104.4

9 pages
OB



THE LECTURE SYSTEM IN TEACHING SCIENCE

Robert T. Morrison

New York University

I must warn you that, since I am an organic chemist, I plan to fill all eight of these blackboards at least twice, and I expect you to get it all down.

You laughed! Fine. Now I don't have to give my talk. I described the lecture system to you and you think it's as ridiculous as I do.

I must confess that the title of my talk is a bit misleading. When I was growing up during the Depression, there was a publisher--in Kansas City, I believe--named E. Haldeman-Julius, and he brought out Little Blue Books. You would see full-page ads in the newspaper: AT LAST! BOOKS ARE CHEAPER THAN HAMBURGERS! And they were--or as cheap. For a nickel, you could get a book on Esperanto, or Freud, or even Maxim Gorki's *Twenty-six Sex-Mad Men and a Girl*. (I bought that one before I found out that they had taken liberties with the title.) In these ads, books were listed by category: science, history, religion, and so on. And under "Religion," you would find such titles as *The Fallacy of Christianity* or *Why I Am an Atheist*.

My talk is about the lecture system in the same way that those books were about religion. Perhaps I should have paraphrased Bertrand Russell by calling my talk "The Fallacy of Lecturing," or "Why I Am an Unbeliever in the Lecture System."

What I am going to say is based mostly on my experience in organic chemistry, both as a student and as a teacher. In my opinion, it applies equally well to teaching any beginning science, or any other beginning subject, for that matter. Organic chemists know more about the abuses of the lecture system than anyone else because traditionally, we have been the worst offenders.

Let me begin by describing a little scene to you. This scene is set in a beginning organic chemistry classroom. The time is any time from a hundred years ago to this very afternoon. The professor has come into the room and is looking out at the class. There may be forty students, there may be four hundred students--it really doesn't matter. In fact, he could be looking into a television camera and teaching all the beginning organic students in the country.

The bell rings, and the professor shuffles his dog-eared notes--they're twenty, even thirty years old, but they're just as good as the day he first wrote them. The students come to attention, notebooks open and pencils poised; they're ready to go. The professor clears his throat, and the pencils move. He says "Good morning," and the pencils begin to move in earnest. Then he turns toward the blackboard and starts to talk. And as he talks, he writes. As he writes, the students write. Whatever he writes, they write. When he draws an arrow, they draw an arrow; when he underlines a word, they underline a word. He finishes one section of the board and goes on to the next. He continues

until he reaches the lower right-hand corner of the last section. Then he erases the board, or pushes it up, and away he goes again.

For a time, all goes well. The professor knows this material cold. He should; he's given the identical lecture dozens of times before. If the students start to show restlessness--or worse, look as though they're about to ask questions--he can always speed up the tempo and take care of that. (When I first arrived at New York University over thirty-five years ago, an older colleague actually gave me that advice. He said, "If you have any trouble with your class, just talk a little faster; that'll keep them in line.")

The students have nothing to complain about. Their seats are comfortable, the ventilation and heating are adequate. The lecturer, if he's a good one, has a loud, clear voice, and his handwriting is not too illegible. He goes slowly enough for them to get most of it down, but fast enough to keep them out of mischief.

Suddenly, disaster strikes! A student drops his pencil! He gropes for it frantically. He can expect no help from his classmates; it's *sauve qui peut* with this crowd. If he finds the pencil immediately, he's all right; but if it takes more than a few minutes he's had it. He might just as well go back to his room and sleep it off.

Back in his room he probably has a copy of the textbook for the course. If you were to take it down and open it, you might find that the first few pages had been read, but if you open it in the middle, there would be a creak and you would be in virgin territory. If the student is a thinking sort of person, it just might occur to him that perhaps he would have been better off if he had never gone to class in the first place. He could have stayed at home and studied the book. But he'd soon reject that idea! It would never do to have empty pages in that magic notebook. He might even study something that wasn't going to be on the examination.

However, the lost pencil episode is not a disaster. If he has a friend in the class who is a good stenographer and a good student, he can borrow the day's notes from him. You sometimes wonder why the whole class doesn't hire a stenographer to take it all down so they could all stay at home. Or they could play softball or go surfing, activities that are healthy. At the end of the day they'd be just about where they would have been if they had gone to class, and they would have a better, more professional set of notes.

Meanwhile, back at the classroom, the lecture is drawing to a close. Just as the bell rings, the lecturer, if he's a really smooth operator, comes to the end of a sentence, a paragraph, a nice neat unit. He lays down his last piece of chalk--he knows exactly how many pieces the lecture will take--picks up his precious lecture notes, and goes out. The students, tired but happy, rise up and follow after him. Their heads are empty, but their notebooks are full. Their necks are a little tired; it's been like a sort of vertical tennis match: board, notebook, board, notebook. But other than that, everything is all right. Any student will tell you, "I never had any trouble with the course until the first examination." There hasn't been a chance to ask any questions, but that's all right; they haven't any questions to ask, anyhow. They've been so busy writing

they haven't had time to think about what was being said; it ran in their ears and out their pencils.

What I have just described is perhaps exaggerated, but not much. You wonder how on earth such a system ever arose because you know very well that nobody in his right mind would invent a system like this today. What I've heard, and I imagine that this is correct, is that it started a very long time ago, when books were rare and very expensive, and the only way to transmit information was for the teacher, who knew, to tell the students, who did not yet know. And they would write it all down and take it away with them, like a bunch of scribes. Remember, scribes were very big in the Middle Ages.

Things have changed a great deal in the past five hundred years. Nowadays there are plenty of books around. They're not exactly given away, but they're still the cheapest item in a student's budget.

So why, then, have we clung to this outdated system? There are undoubtedly a number of reasons, and I want to come back to some of these shortly when I talk about the alternative to this system. But the basic reason, I think, is sheer habit. Our teachers lectured to us, and so we lecture to our students, and they will lecture to theirs, and so on. Coupled with habit is just plain laziness. It is always easier to go on doing what you've been doing and what everybody else is doing than to do something new. This is especially true if what you have been doing is lecturing. Nothing in the world is easier than giving a nice, smooth lecture, especially when the lecture is an old, familiar friend. It's sort of soothing. You know that on November the 6th you'll be discussing the nitration of benzene, and that gives you something to cling to in a changing world.

What is the alternative to this dreadful, wasteful dictation and note-taking? When Boyd and I brought out our first edition in 1959, we were faced with the question of what to do with our class time. The book was based on our lectures which were simply dictated and transcribed and cleaned up a bit. It seemed ridiculous to go into class and simply repeat what was already available in the book. It seemed even sillier to go to class and dictate the contents of a second book, when the students already had all they could possibly handle in one book. (I've heard of this being done. I believe it's called enrichment. I call it overwhelming the student.)

Then, at a meeting in Atlantic City, I happened to run into Frank Lambert. Frank had been a graduate student over in Jones when I was here, and he was then teaching at Occidental College in California. He was giving a talk on this very subject. He was urging what he called "the Gutenberg Method" of teaching--because, of course, it was based on the fact that the printing press had been invented several hundred years ago. Frank became my guru. I still mentally bow toward the west when this subject comes up.

I found out that other people had thought about this problem and were actually doing something about it. Not many--just a small band of dedicated men and women scattered throughout the country, who were fighting an uphill battle against the system. From time to time you will see articles in the *Journal of Chemical Education* on this. George Adkinson, at Waterloo University in Ontario, wrote an article called "Stop Talking and Let the Students Learn to

Learn." He refers to the use of what he calls Bound Optimally Organized Knowledge, known by the acronym of BOOK. (He also comments on the interesting use of the word "cover"--as in "What did you cover in lecture today?" Presumably teaching should involve, not covering, but uncovering.)

What does the Gutenberg Method involve? Simply this. You assign the students portions of the textbook to study before they come to class. When they come into the classroom, they are already acquainted with the material. You don't waste your time, and theirs, outlining the course. You don't waste time telling them that butyric acid smells like rancid butter, and that valeric acid smells like old socks, and other difficult intellectual concepts. The textbook has taken all that drudgery off your hands. You don't waste your time doing what Frank Lambert calls "presenting a boardful of elegantly organized material with beautiful answers to questions that the students have not asked."

The students have read the material, they have thought about it, and they have questions to ask about it. You answer these questions, or, better still, try to get them to answer their own questions, or get other students to give the answers. You ask questions. You have a discussion. If they're slow to come alive, you take up points that you know give students trouble. You lead them through difficult problems. The entire class hour becomes like those few golden moments at the end of an old-fashioned lecture when a few students manage to rise above the system and gather around your desk.

It isn't easy at first. Not for you, and not for the students. It used to be that at least in high school the students learned something in class. But now the lecture system has trickled down insidiously to the high schools. Today students are almost as wedded to the lecture system as the teachers are. They come to college expecting lectures and, come what may, they're going to take notes. Well, it beats thinking, doesn't it? You have to be serious about the Gutenberg Method and you have to be seen to be serious about it. I've had to pry pencils out of hot little hands. I have had to tell them, "Look. I promise. If I give you any important information that isn't in the book, I'll tell you, so you can write it down."

Now, whatever the learning process involves, I think everyone will agree that the first step is the transmittal of information. And here, I believe, you have two alternatives. On the one hand, this initial transfer of information can take place in a crowded classroom, where the student struggles to hear all that is being said, and read all that is being written, and get it all down, in some form or other, in his grubby little notebook. And then, he takes this garbled, illegible, third-hand version of what he thought the lecturer said, or meant to say, and he tries to study it.

Or, you have the alternative. The initial transmittal of information takes place in the student's room from the pages of a carefully written, legibly printed book. And if the author of the book is any good at all, he will have done a much clearer, more thorough, more accurate job than the best lecturer in the world.

Compared with reading, listening is a horribly inefficient way of getting information. Think of how little news you actually get in a half-hour "news"

broadcast on television. Why, in a half-hour you can read half the *New York Times* and you can skip or skim what you already know or aren't interested in.

I happen to be a lover of theater. Every so often, my wife and I go on a binge and gorge ourselves on theater the way some people gorge themselves on bacon sandwiches. And theater, at its best, is enormously stimulating and thought-provoking. Still, even at its best, compared with reading, theater is a spectator sport. Reading makes demands on you. You must work at it. And because of the work you do, reading stretches your mind.

Learning, be it chemistry, physics, or biology, is not a spectator sport. A student doesn't learn sitting on the aisle in a lecture room watching a spectacular performance by a star lecturer.

What the Gutenberg Method offers, then, is two things, either of which alone would make it worthwhile. First, you have a better mechanism for the initial transmittal of information, one that is more efficient and more effective. Second, the big bonus and the reason for the Gutenberg Method in the first place is that you gain all that lovely class time for doing what you hardly get to do under the lecture system, and that is teach.

I said that the Gutenberg Method wasn't easy for the students at first. Naturally. They're going to be learning during the class hour, not just scribbling in their notebooks. And learning isn't easy. You get what you pay for. There's no free lunch. But the students will come round. They are, by and large, highly motivated, particularly students in the sciences. If you told a class of premedical students that it would improve their chance of getting into medical school if they learned the contents of the Manhattan Telephone Directory, some of them would sit down happily and get to work. They've got lots of incentive.

It's the teachers who find it particularly hard to switch to the Gutenberg Method. It's more work for them, too--a lot more. Of course it is. Teaching isn't easy, either. Surely it must occur to every teacher at some time or other that lecturing is a suspiciously easy way to do what must be a tough job.

But I believe that, for a teacher, there is more to this than just having to work harder. I wasn't joking when I said that lecturing is soothing and reassuring to the lecturer. I think that everyone, at least one part of everyone, wants the security of knowing what is going to happen. And you certainly know exactly what is going to happen when you give a lecture--it's all planned ahead. So there is a reluctance to come down from the stage where you're reciting your prepared lines, and start to exchange ad-lib comments with the audience.

I think that something else is involved here, too. I think all of us, to a greater or lesser extent, indulge in wishful thinking. We lecture to students with the belief, the wish, that they are learning. But we put off the moment of truth--the moment when we find out whether or not we're really getting through to them--until the next examination: a week, a month, maybe longer. And even then, we are cushioned against any shocks we might get, such as finding out that a lot of them are not learning. It's a written examination and,

while we may grade the examination, it's still a matter of marks on pieces of paper, just names and grades.

But when you take the plunge into a discussion, you've moved from a theater to a swimming pool and you're sometimes shocked by the cold water of reality. You find out, not next week or next month, but today, eyeball-to-eyeball, that some students have only the fuzziest idea of what you've been trying to put across. "I can call voices from the vasty deep." "Why, so can I, or so can any man. But will they come when you do call them?"

What I've said so far is my basic thesis. Now I'd like to bring up some qualifications, reservations, and exceptions, though even the exceptions will have exceptions to them. I have rebuttals to objections you haven't had a chance to make yet. You see, this is a real lecture.

First, there is the matter of class size. When you think of "discussion," you think of 20 students, 30 at most. And, ideally, you're right. But Frank Lambert has used the Gutenberg Method successfully with classes of up to 125. Boyd and I have done it with classes of 100, the largest we had. You don't reach every student every day, of course, but you don't do badly. For every student who has a question in a large class, there are probably a dozen others who have the same question, so you're handling theirs, too. The important thing is that whatever you do in class they're paying attention; they're not busy scribbling. Any step you take in the direction of discussion is a vast improvement over lecturing. You may say teachers are expensive, and we can't afford enough of them to handle discussions. I agree that teachers are expensive, and we can't afford to waste the ones we've got on this glorified stenography.

Now, of course, for the Gutenberg Method you must have a book, a book that in general you find acceptable, one that goes along the same lines that you do. But you do not have to agree with everything in it. You may think some things in the book are just plain wrong. That's no problem--just tell the students what's right. You may feel that some topics are unnecessary. All right, tell the students to omit them. You may feel that some topics are neglected or presented less than perfectly. Fine, you have all that lovely class time available to you to make up for the deficiencies of the book. But if you add new material, you should write it up and hand it out ahead of time. It is all to the good for the students to see that there can be different points of view. Furthermore, they think you're great--you know more than the guy who wrote the book.

A point about the content of the book, or the content of a course, for that matter. As long as the book does what it does do well, it doesn't really matter if it leaves out some topic unless it is one that is absolutely fundamental. You fill in the gap, and the students have learned enough to be able to handle it.

Now, if you can't find a book that is even remotely acceptable to you, then you have to write your own. That's how books get written. (Well, actually, it's how books get started; they get finished because your third child is on the way, and you have no money to pay the rent.)

The Gutenberg Method, then, is one that uses a book. But if it is to work, the book must be written with this end in mind, or as though this end was in mind.

It should not be a reference book jampacked with ten times the facts and information that a student can hope to learn. It should not be a short, concise summary written to help the student review. It must be written to be the student's initial contact with the subject. New ideas must be introduced, as though the students were completely ignorant, which, at this stage, they are. Explanations must be full enough, complete enough, that the students can understand them. This means using many words and many pages. Other things being equal, such a book will be long, not because it discusses a great many more topics, but because it deals properly with those it treats.

Now, when Boyd and I brought out the first edition of our book twenty-six years ago, it turned out to be that kind of book. It was long, and it didn't have a whole lot in it by 1959 standards. Somebody said that where older books used a sentence, we used a paragraph. I think he meant that as a compliment. Nowadays, of course, all beginning organic books, including our own, are big--too big, I think.

But the way our book turned out was due to ignorance, actually to a coincidence of two ignorances--our own and our publishers. When we wrote the book, neither Boyd nor I had ever really studied or even read a beginning organic book. When we were students, we hadn't used our textbooks; there was too much in them for us to learn. Like everybody else, we took notes faithfully and studied from them. As teachers, we had to help select textbooks for our students, and we must have looked some over a bit, but we were working up a new way to teach organic chemistry, and we couldn't expect much help from any textbook.

When we wrote our book, we wrote it the way we thought all books were written. We explained everything, the way you would in class. We used as many words as seemed necessary to get a point across. We didn't realize how long the book would be because, as we finished chapters, we shipped them off to Boston.

Now, if our publishers had been old hands at organic chemistry, if, for example, we had been dealing with the clever, sophisticated people who now man the editorial desks, they would have sent that manuscript back to us to compress into a tiny fraction of its size. But, by great good fortune, they didn't know what they were doing either! At the college level, they had only published one science book, a mathematics book, and they hadn't the faintest idea of what to expect of an organic chemistry book. I have probably exchanged as many hot, indignant letters with my editors as anybody alive, but I will be everlastingly grateful to them for keeping their blue pencils away from our first manuscript. Believe me, there can be worse qualities in a publisher than ignorance.

There is the matter of advanced courses or new courses, for which no book is available. But even here, you can liberate the students from note-taking. You can hand out duplicated notes so that they can be studied before class. Unless you're only an hour or two ahead of the students in your preparation or just winging it in class, you must have something that you can share with the

students. You owe them that much. Furthermore, you will have all that material available for writing your new book.

Now you may say, "What about the stimulating lecturer?" No book can hope to compare with a really stimulating lecturer. My response is that if a teacher is stimulating as a lecturer, think how much more stimulating he can be when he stops dictating and starts teaching. The comparison is not between the teacher and the book; the comparison is between the teacher as lecturer and the teacher as teacher.

What makes a teacher stimulating? Is it really the elegant presentation of a beautifully organized lecture? The students may admire a performance like that, and enjoy it as a *tour de force*; the lectures may be enormously popular and play to packed houses--but are admiration and passive enjoyment really what is wanted?

What we really want to do is strike a spark in the students' minds. We want to reveal to them the beauty of ideas and concepts and rationality. The teacher and his personality play the key role in this. But it is not the teacher's wit and polish and delivery that are important. It is the teacher's enthusiasm for the subject that is enormously contagious. It is the students' seeing how a mind better trained than theirs approaches an intellectual problem. It is the intense pleasure the students get when they are led, like Socrates' slave-boy, to use, really use, their own minds. Surely, this is the kind of stimulation that we are looking for.

In my own education, several things stand out. When I was a first-year graduate student here, we had physical chemistry seminars every Monday noon. There was lunch, served by us graduate students. (I've often thought of writing a memoir: *Nobel Prize Winners I Have Spilled Soup On.*) These seminars weren't really on physical chemistry. They were about all sorts of things; I can remember Rashevsky speaking on mathematical biophysics. So everybody, faculty and graduate students alike, was starting off from scratch. And what has stuck in my memory about these seminars was observing the workings of James Franck's mind. James Franck was, of course, a Nobel prize-winning photochemist, but the questions he asked were simple, direct, and fundamental--the kinds of questions beginning students sometimes ask. Sometimes the kind, I'm happy to say, that I wanted to ask myself but, as a first-year graduate student, was afraid to. To see that tremendous mind strip away the frills and go directly to the heart of the matter is something I'll never forget.

Later, in the early 1950's, when I had first gone to N.Y.U., there was a series of talks on organic chemistry at the Union Carbide Building in New York. I remember a talk by Christopher Ingold, the famous English chemist, and particularly a very small point he made. He was discussing the mechanism of nitration and the matter of hydrogen bonding in the reaction mixture was raised by a questioner. I can remember Ingold's answer. He pointed out that the solvent, concentrated sulfuric acid, was itself highly hydrogen-bonded. (In my mind's eye I can see him shaking an Erlenmeyer flask, though I know he really had nothing in his hand.) And he said something like this: "Well, of course,

you can see that--think how viscous it is." And a light bulb went on in my brain! Here was something I had observed a thousand times, something every high school student knows: concentrated sulfuric acid is a thick syrupy liquid. And I knew about hydrogen bonding: you draw a letter "H" and you attach a solid line to one side and a broken line to the other. But I had never before made the connection. Oh, Ingold did a beautiful, elegant job of delivering his talk. But what I remember is that glimpse of a great, very simple mind at work. That was stimulation.

I'm sorry if I seem to have been preaching at you. But this is something I feel very strongly about. For a number of years I've been traveling about, setting up my tent at fairgrounds all around the country, trying to bring religion to the heathen. As I learned many years ago at my sainted mother's knee, there's nothing worse than a reformed drunkard or a reformed whore. For twenty years I used to hit the lecture bottle regularly, four or five times every week. But now, brothers and sisters, I've seen the light, and I've reformed. Hallelujah!