4-6-1976

Lecture 1: Ideas on Teaching

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"THE LAST LECTURE"

Ideas on Teaching

By Garth L Lee

APRIL 6, 1976
8:00 pm

Business Building Auditorium
"THE LAST LECTURE"—to be presented by Garth L. Lee, Business Building Auditorium, April 6, 1976.

"Ideas on Teaching"

It is most pleasing to me to have the opportunity to be judged in the area of my greatest competency. I, usually judge and feel that I am judged in my department upon research where I am a constant loser. I am reminded of the story of the young man who was in love with two girls. One was very beautiful, the other was a marvelous singer. The young man married the singer. One night he had worked late at the office. He stopped at a traffic light on the way home in front of a theatre marque where he saw the beautiful girl in a beautiful gown escorted into the theatre. When he arrived at home, his wife had already retired. He walked swiftly to the bedroom; threw the covers back and screamed, "Get up and sing!" I feel like I have been told to get up and sing.

I have been asked to speak on my personal philosophy. This would be difficult for me. I do not even know the terms that a philosopher uses. Actually, I have never worried about my philosophy. I have worried about doing my job well. I think that I shall tell about some of the things I do. Perhaps, the philosophy will spill out.

I carry the chemicals and equipment for demonstrations, my exams and other such materials that I use in this. (A yellow plastic bucket.) As I carry it across the campus from the chemistry building to the engineering lecture room, I am subjected to verbal abuse. I hear, "Have you finally gotten a job as a custodian?" "Are you off to milk your cow?" "Did you bring your lunch this morning?" Finally, I have to explain to the class (and I do). I let them know that the questions merely reveal their ignorance. While the container is somewhat unusual, it is most useful. And should they desire to obtain one, they can be obtained at certain hardware and equipment stores. They are to ask for, "A briefcase in the round w o z".
The "w o z" is very important. Unless they stipulate "w o z", the price is much higher. "W o z" means WithOut Zipper.

I think that education and lectures should be painted fun. I think that few activities are more enjoyable than learning. As necessary as they seem to be, the anticipation of grades takes a lot of fun out of the university experience. I think the instructor has a responsibility to conduct the class in such a way as to help the student forget the fact that grades are to be assigned. The threat of possibly achieving a poor grade may serve well as an incentive to bring some students to the study table; once he/she is there, it is a hindrance to learning.

One reason that students do so poorly in examinations, is that they bear the burdens of eternity when they write an exam. It goes something like this, "I don't know the answer to this question. If I don't know this question, I might not know many others. If I don't know the other questions, I may fail the exam. If I fail the examination, I may fail the course. If I fail this course, I may be kicked out of school. If I am kicked out of school, I will have to go home without my degree. If I go home without my degree, I will be a disgrace to my people. If I -- etc., etc.". At that instant, the student is trying to solve all the problems in his/her life. And most of the problems are insoluble, certainly at the time of the examination. In a far better attitude, is the student, who comes in five minutes late, not caring whether he/she passes the "thing" or not. When he/she looks at the question, he/she sees only the question. His/her chances of using his/her faculties to solve the problems are much greater.

When I attended movies years ago while I was a University student, I watched Errol Flynn when with the sword he vanquished multitudes. I found that even as he fought them, they graciously lined up such that he could fight them one at a time.

Humor may be used to decrease tensions, to release a student such that he/she can learn. This comes easily for me. Many things appear amusing to me, and seldom do I miss telling the class. The use of humor is dangerous,
however. One must be careful. I tell the students during the first class hour of the term, that I mention anything that is funny to me; that I mean no offence in anything I say. Occasionally, I watch to find a student alone (when I fear that I have offended him/her) and apologize.

For most of my lectures I take a piece of apparatus, a few chemicals, a model or two for what I call a "demonstration". Usually, it is a very simple operation. Those are the best "demonstrations." More sophisticated demonstrations take a great amount of time to prepare, take time to explain details of operation with too little time to explain the principle. Consider this demonstration, simple but more elaborate than most. See what you can do with it. See where it can lead you. (A coil of copper wire is heated in the flame of a torch until it glows with a red light. The wire is suspended in an erlenmeyer flask such that the glowing coil is above a concentrated solution of ammonia in the flask. Above the liquid level, the coil continues to glow, often very vigorously, some times melting pieces off the end of the wire.)

The experiment may be used in various ways to introduce many facts and principles. It may be used
1. As evidence that a chemical reaction is occurring, because the coil is kept glowing by the continual addition of heat from some source.
2. As a demonstration of an exothermic (heat evolving) reaction.
3. By first having a student carefully smell the ammonia fumes to identify them. Them by placing a match box over the mouth of the flask such that the oxygen of the air is excluded and the coil ceases to glow, the chemical reactants can be demonstrated.
4. As evidence of catalysis. It is obvious by the continual glowing of the coil and the heating of the flask in that region, that the reaction is occurring on the surface of the copper, that in some way, the copper assists
the chemical reaction to proceed.

Once the reactants are known to be ammonia gas, \( \text{NH}_3 \), and oxygen \( \text{O}_2 \), the student can understand the reaction taking place as represented by this equation,

\[ 4 \text{NH}_3 + 5 \text{O}_2 \rightarrow 4 \text{NO} + 6 \text{H}_2\text{O} \]

The student can follow the reaction (which does not stop) in one step. In the moist air in the mixture above the ammonia, nitric oxide (NO) is oxidized to nitrogen dioxide, \( \text{NO}_2 \),

\[ 2 \text{NO} + \text{O}_2 \rightarrow 2 \text{NO}_2 \]

and in the solution, nitric acid, \( \text{HNO}_3 \) is formed

\[ 3 \text{NO}_2 + \text{H}_2\text{O} \rightarrow 2 \text{HNO}_3 + \text{NO} \]

to be converted immediately in the ammonia solution to ammonium nitrate, \( \text{NH}_4\text{NO}_3 \),

\[ \text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3 \, . \]

When the water is evaporated from the solution, white, solid ammonium nitrate will remain. Ammonium nitrate is both a very common fertilizer and a powerful explosive. To be a powerful explosive, a sudden reaction must occur which turns a solid or liquid to a gas or gases and releases a great amount of heat to expand the gasses formed. Using models the instructor can show the students how the solid ammonium nitrate might detonated, why it explodes when it is suddenly compressed. See what ammonium nitrate looks like. It is made of many, many of these separate units, ammonium ion, \( \text{NH}_4^+ \) and nitrate ion \( \text{NO}_3^- \). [Holds the three dimensional molecular models].

\[ \text{H} \quad \text{H} \quad \text{O} \]
\[ \text{N}^+ \quad \text{N}^- \quad \text{O} \]
\[ \text{H} \quad \text{H} \]

Watch the position of the atoms. Because the equation is,

\[ \text{H} - \text{N} - \text{H}^+ + \text{N}-\text{O}^- \rightarrow \text{NNO} + 2 \text{H}_2\text{O} \, , \]
\[ \text{H} \quad \text{O} \quad \text{H} \]
the atoms must come out in the groups NNO and H-O and H-O

See how this can happen. (Pushes the ions together and shows that the atoms are in the correct positions to form the new molecules.)

Can you see how much fun it is to teach chemistry. You can help others to see how things really go—or how they might go. And that's not all there is to teaching chemistry. There are the economic factors that make one process feasible that rule out another. There are political factors. One of the reactions discussed with the little demonstration shown this evening had a profound effect on history. Nitric acid which was produced along the way is used in producing explosives. The discovery of that process, (the production of nitric acid from ammonia) called the Ostwald Process, by a German scientist shortly before the First World War, extended the war at least several months. Then there is the mathematics involved in relating the amounts of substances that combine, the amounts that can be produced, the dependence of the rates of reactions on temperature and amounts of reactants. To cap it off, we can take the student into the laboratory to actually carry out some of the reactions and see the real world of chemistry.

I believe in the lecture system in chemistry teaching. I think that a good teacher can involve the students in thinking and interacting. I think that he can explain concepts and can explain the solutions to problems in such a way, even in a class of 200, that most of the students can do them. I think that he can demonstrate ideas well enough that the student might use three hours to gain equal understanding outside of class.

I study hard and prepare my lectures very thoroughly. I rewrite notes for each lecture. More importantly, I rethink each lecture. I do this despite the fact that I have taught the course or similar courses for more than 25 years. And despite the fact that I have authored and co-authored textbooks for the course, I need always to liven-up the material. Each
class I teach is a different class. Each has a different interest in the material. I like to follow, wherever possible, the particular examples that excite them to illustrate the principles that must be taught. Sometimes their questions lead me into areas that are new and exciting to me.

I want to be well enough prepared that I can answer their questions and demonstrate methods of working problems without having to stop and ponder. I hate to waste their time. Of course, I cannot answer all their questions. When I can't, I tell them, "I don't know." It's not often that I cannot answer the questions. Many are brighter than I (and I'm glad for that) but with years of experience, I can anticipate and be prepared for most queries. Sometimes, too-often, I make little errors, such as forgetting a minus sign or multiplying $2 \times 3$ to get 5. The students may attack me on the point, saying, "You mark us wrong on examinations for making those mistakes and yet you make them all the time." My answer is, "That's right, and I'm sorry but I'm going to take this course over again next year. That's all that I'd ask you to do."

I like to be well enough prepared that I can "hang loose". I like to be relaxed. I like to be able to take an example that a student has brought-up in his questioning and "hang" my principle on it. I like to be able to switch examples when one doesn't go. I like to be able to jump from a prepared discussion when I find that it is already understood to a topic that the students need help in understanding.

I try to have the examinations corrected and back, in no more than two or three days. I want to cut the suspense and I want them to learn from their errors while they still remember the questions. I am always willing to discuss the questions with the students. Some instructors have the policy of regrading the entire examination, when a student questions the grading on one of the questions. The idea is that if you can find more points to subtract than you might have to add, it is good for the student. I do not do this, I want to help them. A student learns something when he
builds a case to support an answer that has not been accepted.

If I am to return examination papers on time, the size of the class affects the kind of examinations I must give. I like to give so-called written exams which call for written answers and written solutions to problems. As classes become larger, part of the exam questions must be of the multiple choice type, where the student chooses the best answer from a series of choices. Multiple choice questions are more easily graded but are more difficult to write. Those questions must be stated more carefully because no allowance can be made in the grading for a student's misunderstanding of the question. It takes at least 100 students to make it time saving to use multiple choice questions. Of course, new questions should be written for each exam without recourse to questions that have been used before. Then questions will be drawn from ideas that you and those students who have followed the lectures have been thinking about.

I try to be available to students for consultation as much as possible. I want to be available to all students. I try to teach my courses at such a level that many students will need help. I think the one aspect of college teaching in which we do students the most disservice is in presenting material to them that is not sufficiently challenging. The university is an educational institution—where the education dispersed is primarily in the class room. Students can learn much in other activities and in their interactions together but the class room is unique in the adult world to the university. The most important experiences are found there and in the study directed from the class room. Time is wasted unless a student who carries 16 credits has a full weeks work—a good 48 hour week. If the average student can hold down a job and achieve C grades, all other students are being cheated.

My first responsibility is to teach difficult material. Consequently, many students will have difficulty understanding. My second responsibility is to present it such that it is available to them. Non vocational material
should be taught in as great a depth as material that prepares a student for a vocation. There is enough to teach in all disciplines. If the material is not difficult, the instructor is either lazy or incompetent.

To be available for consultation, I must not only be in my office where I can be found when needed, but I must not be overly pressed with other matters. If so, I am short tempered and haven't the patience to help the student who is lost.

Research work is a very valuable endeavor in itself and the contributions it makes directly to society are important. Research under the direction of an active and concerned director is a great teaching activity. The master-apprentice relationship is the best arrangement for learning. However, it is very expensive in time per person. Research and creative activity on the part of an instructor tends to keep him alive and enthusiastic about his teaching, especially if his teaching area is the same as his research area. However, if an instructor becomes pressed in directing his graduate students, in writing papers and in submitting proposals for research funding, he may find he has not patience for the "dumb" students that come to him for help. He may not find time to prepare for his lectures; to think about them. Because promotion and salary may depend upon research productivity, his research activity may be a serious problem in his teaching.

I think "outside" activities can be helpful to an instructor to keep him/her alive. The instructor should be an active citizen and should support civic programs that he/she feels are beneficial to all. But he/she can not be carried away on all crusades. Hobbies may be a useful activity and serve to keep the instructor human. However, if he/she becomes obsessed with them, or if they become a means of supplementing his/her monetary income, they may become a great liability.

I am available to students as many hours as possible during the day. Many come to my office. Some instructors say, "Let the student list the questions he has, then come and ask them all at once." Sometimes this is possible. However, much of chemistry builds on a stairway such that a succeeding topic cannot be understood without an understanding of preceding ideas. I would like to help the student move ahead. When students have
questions, I am often tempted to ask questions and lead them to the answer themselves. That should be the best way. However, I find that many students are shy and fear that if there is a succession of questions all they will do is reveal their ignorance to the teacher. I use the progressive question technique only when I know the student well enough that it won't drive him away.

If the course material is difficult, some students will fail the course. I understand that a failure can be difficult for a student to "handle", especially because many never faced the possibility of a failure. With extra work to raise grades in high school, social promotions, and parents to fight for them, they can't fail. However, it seems to me that one of the contributions of a college experience is to show a student his/her strengths and weaknesses. To help the student find a field of study where he/she can make a real contribution and to avoid an area where there will be little satisfaction and little recognition from others.

I'm just where I want to be in the university. Since I can't be a student all my life (a registered student), I'm glad that I am an instructor. I like to think that I am a member of the second most important group on the campus. The most important by far being the students. It is because students are to be helped that the university exists. I belong to the group that works with the students directly in the purpose for which they come. I become very impatient with those employees of the University who don't seem to remember the students. We are not here to keep an office force happy. We are not here to make and deliver reports to the higher education board. We are not here to collect funds. We are not here to make out affirmative action reports. All these activities are most important and must be done but they are secondary to the task of teaching students. All auxiliary activities should be arranged such as to be as pleasant and free of "red tape" as possible for the students. I understand the need for vice presidents and
custodians, but I'm happy to be an instructor. It's easier to find a meaning or a mission in my work.

Years ago, long before I came to this University, there was an English professor at Utah State whom the students affectionately called "Fuzzy" Arnold. I am told that one commencement time, he stood at his office window watching the students arriving with their caps and gowns for the procession. As he watched them, he said, "They come to us like little bottles. We fill them up and put on the cap". While this analysis of teaching-learning is greatly oversimplified, I feel most favored to be one who helps fill the bottles.