Instant replay and the graduate teaching assistant

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An innovative course for graduate teaching assistants at the University of California at Berkeley aims to familiarize TAs with techniques besides lecturing (i.e., question-and-answer, discussion, small-group problem-solving) and to demonstrate how teachers' classroom behaviors affect students' learning. The format is threefold: (1) Each TA is videotaped while teaching; (2) each analyzes his videotape privately and with the instructor; (3) weekly seminars are held. The authors concluded that, as a result of this course: (1) TAs felt freer to experiment with a variety of techniques; (2) verbal interaction between students and TAs and among students increased; (3) TAs' behavior changes were noted and appreciated by students.

INTRODUCTION

At the University of California's Berkeley campus, approximately 40% of the teaching is done by graduate teaching assistants (TAs) who are given little if any training or background in principles of learning and techniques of teaching. Further, it has been ascertained that more than 50% of all graduate students (exclusive of those trained in the School of Education) are eventually employed in an academic setting. These men and women have received nothing in the way of training for becoming effective teachers. The situation on this campus is not unique, but typical of that at most (large) academic institutions. However, more and more professors are beginning to pay attention to the dynamics of the learning–teaching relationship and are experimenting with ways of ameliorating the situation described above. The *American Journal of Physics* alone has published several articles during the past decade which bear directly on this problem.[1–7] The paper which follows describes one such innovative experiment which is being used in the physics department and is stimulating an interdepartmental interest at U.C. Berkeley.

After methodological observation of TA-taught discussion sections (the name given to the small group breakdowns of the large faculty-taught lecture courses), several constants emerged which characterize present TAs' teaching methods:

(1) There is a very high percentage of teacher-talk, amounting in most instances to a lecture.

(2) Interaction usually takes the form of questions which are rhetorical (i.e., requiring no answer or so involved that they become part of the lecture) or are of the yes/no variety, offering the TA little feedback and the students little opportunity to manipulate verbally the ideas and material of the course.

(3) There is a widespread insensitivity to students' needs and problems. This can be attributed to the lack of communicative interaction in these "discussion" sections.

The U.C. Physics Department hires approximately 70 TA's each quarter, most of whom participate in the undergraduate program responsible for the instruction of physics to between 2000 and 3000 students each quarter. An experimental course was set up by the authors in order to satisfy the obvious needs of graduate assistants to be exposed to learning principles and to experiment with teaching behaviors which facilitate students' significant (as different from "rote") learning as demonstrated in the research literature.[8]

The goals of this innovative course were (1) to sensitize the TAs to the important role which is played by their behavior in setting a facilitative learning "climate" in the classroom, i.e., providing the kinds of psychological comfort for students which will free them to ask questions, respond to questions, and participate in learning; (2) to enable the TAs to become facile in raising the level of students' thinking from low-level recall of factual information to higher-level analysis via a structured questioning strategy; and (3) to encourage the TAs to become aware of their roles as "model learners" and, in this role, to model analytical, methodological thinking behavior in problem-solving.

THE COURSE

The format of this ten-weeks' course is described in Table I. Depending on the particular needs and interests of each group, the syllabus was added to, varied from, or modified slightly. However, there were basic constants; it is these which are mentioned.

OBSERVATIONS

The course, which is being offered on a volunteer basis for the sixth consecutive quarter in two years, has attracted approximately one-third of the graduate physics TAs and has already demonstrated positive results, both from students and TAs.

The physics students have responded to the TAs' new methods by according them higher ratings and perceptive, appreciative comments. This was documented by a study of pre- and post-evaluations of participating TAs by their students, plus a comparison of these ratings to *all* physics TA ratings during the same period. The following examples of student comments have been chosen to illustrate

the way this course is effecting changes in TA behavior:

> For three years at Cal I've come across few TAs who seem as genuinely concerned about the students and their problems as you are.
>
> You lead us rather than just putting an answer on the board. You leave it up to us to pool our information and help each other out.
>
> You put a lot of effort into being a good TA unlike most other TAs.
>
> I wish we could have more discussion times. Most of my practical physics learning (problem-solving ability) seems to be coming from my TAs handling of discussion sections—making *us* ask the questions and having us as a class try to work out problems together.

Most of the participating TAs have given the course accolades and stressed its utility to themselves both as teachers and as social beings. Some examples of TA comments during and after exposure to this course are quoted here:

> I realized [when replaying the videotape recording of his discussion section] that I don't listen to what my students have to say. I wait for an appropriate moment when they're speaking, interrupt, and go into "my own thing."
>
> I need to make sure the knowledge is there (by asking questions or setting the problem up) and then *let the students* work it out. That's how they learn.
>
> I put the problem on the board and then sat down among them. The class began to work it out and got so involved that they didn't want to leave when the hour was up. It was the greatest lesson!
>
> I tried expanding my "wait-time," and when the students began to respond, I couldn't believe the misconceptions they'd held about some really basic concepts. If I hadn't allowed them time to speak up, I'd never have guessed at the gaps in their understanding of certain problems; I'd just have gone on talking over their heads 'til final exams.

CONCLUSIONS

This course has demonstrated that when the instructors model and discuss those behaviors which facilitate learning (utilizing the principles of behavior modification[11]), and the participants themselves analyze videotaped recordings of their own classroom teaching, TAs have been able, in varying degrees, to effect changes in their classroom teaching behavior. The teacher-dominated lecture method was varied to include discussions, question-and-answer dialogues, problem analyses in small groups, and individualization. An emphasis heretofore solely on informational transfer was expanded to include method and problem-solving.

Because teaching assistants exert such an important influence on the undergraduate teaching program, their behavior change is a most important one. A course such as this one has the potential for improving the level of TA competence and thereby raising the quality of undergraduate instruction and learning. The methods of this program and course can be implemented in any subject

Table I. Syllabus for the ten-week course.

Week Number One

(A) Organization of course procedure.
- (1) Introductions
- (2) Hand-out and explanation of course notes (derived from Parsons' *Guided Self-Analysis System*[9] plus additional material designed by the authors).
- (3) Videotaping schedule set up for each TA.
- (4) Videotaping of this session and playback to familiarize participants with camera, filming, and equipment.

(B) Discussion
- (1) What are the goals of teaching TA sections?
- (2) How do you create a "climate" in the classroom where these goals can be realized? (Personalize; ask open-ended questions; use students' ideas; "listen" to students.)

Week Number Two

(A) Discussion
- (1) What is learning? (An ability to use and manipulate facts and concepts in order to solve problems; a change in behavior, etc.)
- (2) How do people learn? (They move from the known to the unknown, from the simple to the complex; this involves attending, being motivated, and participating.)
- (3) What are the purposes of questions?
- (4) How do we develop a questioning strategy, i.e., move questions from those demanding low-level informational recall to higher-level tasks of analysis, synthesis, evaluation?
- (5) What facilitates concept development?

(B) During this week, each TA will have been videotaped while teaching. Each is required to view his videotape recording (VTR) and come prepared next week to share his analysis of his own questioning strategy.

Week Number Three

(A) Participants will analyze their questioning patterns and techniques—showing examples on their VTR's.

(B) Discussion
1. "Wait-time"[10]
   - a. Why is "wait-time" important?
   - b. What are some reasons that we fear silence?
2. Facilitating responses
   - a. How can we encourage, rather than close off, students' thinking about and interacting with the course material?
3. What are some other techniques besides lecturing which can be used in the classroom to facilitate learning? (question-and-answer; discussion; small group problem-solving; projects; reports). Each is encouraged to try one and report each week.

Weeks Four Through Eight

(A) Continued analyses by each participant of his VTR, attention being paid to student-teacher talk patterns and their effects on student thinking and learning; questions; responses; the teacher's personality, ego, and his classroom manner; the creation of a learning climate. Typical and innovative class situations are play-acted and analyzed.

Week Number Nine

(A) A second VTR having been made of each TA, these are analyzed, compared with the first, and evaluated.

Week Number Ten

(A) Final class evaluations and resumés.

area, since they are independent of the instructional material of any specific discipline. They direct attention to those teaching behaviors which encourage independent thinking, critical analyses, problem-solving abilities, and personal responsibility for learning.

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COFFEE LACED WITH POLYGONS

If you examine a hot cup of coffee under a strong light that is incident nearly parallel to the surface of the coffee, you will find the surface laced with polygonal cells. They disappear, however, as the coffee cools. You can also destroy the cellular appearance by putting a charged rubber comb (charge it by running it through your hair) near the coffee.

Other liquids show surface designs, too. James Thomson, a famous 19th Century physicist, noticed the rapidly varying surface designs in a pail of hot soapy water and in strong wines. Later, the Frenchman Bernard was able to make regular patterns in oil surfaces when the oil was heated from below. His regular polygons would slowly evolve into a beautiful hexagonal, honeycomb structure. Still other fluids gave a roll-like appearance.

Recently, cellular surface designs were attempted on board spacecraft while under zero gravity.

In these examples, who do rolls and polygons (especially honeycombs) form on the fluid surfaces? Is the same physics actually responsible for all of the examples? Why do the coffee cells disappear when there is a charged body nearby? Finally, do these several types of surface designs depend on gravity? [From *The Flying Circus of Physics* by Jearl Walker.]