SPEAKING OF TEACHING

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Designing and Teaching a Course

Whether you call it "instructional planning," "course design," or "syllabus preparation," all faculty members must engage in some form of conceptualization when they offer a new course or revise an existing one. Designing a course is one of the abilities faculty are assumed to have picked up somewhere in their graduate preparation, although few have taken a pedagogy course while in graduate school. And even for the self-motivated, the literature about course preparation, though plentiful enough, is not always readily at hand, suggesting that many faculty members plan rather intuitively. Given the amount of research showing that good course design is fundamental to teaching effectiveness, and considering the many well-received required courses and innovative electives across the schools, Stanford faculty clearly have found ways to plan and teach students at all levels, challenging them to active learning. The fact that faculty revise and tinker with even successful courses indicates that they reflect on the way the course worked, and often on the process by which they created it.

To Russell Fernald, Benjamin Scott Crocker Professor of Human Biology and Psychology (Teaching) and Director of the Program in Human Biology, the lack of models for developing and teaching a course proves no deterrent. He relishes the process of conceptualizing, organizing, and then teaching and updating the new courses he has introduced since coming to Stanford. Fernald shared his method with colleagues in an Award-Winning Teachers on Teaching lecture-demonstration in spring 1997. This issue of *Speaking of Teaching* follows the outline of that talk, supplementing it with a number of materials in CTL's library, World Wide Web sites featuring "how-to's" of course design, and suggestions from Stanford faculty and teaching assistants. An annotated bibliography is included to guide teachers to the resources available.

The Idea and the Courses

Fernald's course design model goes beyond describing ideal objectives and explains the process of implementing them by means of a carefully scheduled syllabus and specific pedagogical principles that suit the student learning objectives. An important component of course design to Fernald is building in assessment procedures so that the instructor can measure the effectiveness of the principles and methods. This model is especially useful because of its adaptability to any school and department at Stanford.

Fernald's "case study" examples are "Introduction to Brain and Behavior," and the year-long course on light in the Science Core, taught in a team with three other professors: Patricia Burchat, Associate Professor of Physics; Sharon Long, Professor of Biology; and Brad Osgood, Professor of Electrical Engineering. The goal of both courses is to present scientific material to nonspecialists. This does not mean teaching more simply, Fernald says; it is actually harder. "First, the students won't put up with endless small details in the hope there will be a payoff at the end of the quarter, which is the way advanced courses for majors are frequently taught. These students have to be motivated to learn; therefore, they want to get the issues right away and to understand the concepts involved." In other words, because the purpose of a course is to facilitate student learning, the first step in planning a course is anticipating who will take it.

Considering the Audience

In order to determine course objectives, it is important to first reflect on the likely student population of the class, and, most importantly, whether the course is required or an elective. Professor Fernald warns colleagues against making required courses into ones students fear or dread. Viewing required courses as a chance to "weed out" students can lead to a "hazing mentality" that is damaging to students, particularly vulnerable populations such as those testing out a major. Sheila Tobias, who studies gender differences in math and science, agrees with this warning; according to her, students believe that math and science courses are intentionally taught and graded so that only the elite will continue. She also cites research that shows negative if not hostile conditions prevailing in some math and science courses, creating a "chilly climate" particularly harmful to young women. Also, students who might otherwise have become math and science majors

drop out because often teachers in these courses teach exclusively in a vertical manner; if the first step is missed, it is difficult to go on. Students who have the aptitude but do not pursue careers in science also complain about courses that are improperly paced. If the pace is too fast, they cannot experience the pleasure of exploring and mastering a topic. To them it seems as if it is "a rush to climb the next mountain."

Of course, faculty members also select or invent courses to teach, proposing them either because of topical interest (examples are the politics and principles of affirmative action, and the social and psychological dimensions of AIDS), or because the subject falls within their area or specialty. But even with courses that aren't required for undergraduates, designing an effective course presents challenges. Fernald uses his "Brain and Behavior" course to illustrate how difficult it can be to navigate through the process of planning the syllabus when the subject is both topical and the instructor's focus of research. This course is not only tied to current events, including AIDS, but it overlaps his research into how, under some conditions, behavior can actually change brain structures. As an introductory course its primary goal is "to help students think critically about scientific evidence, learn to evaluate the validity of research, and determine its relevance to important issues in their own lives." But the fact that neuroscientists are discovering information so fast about the complex links between mind and brain leads to challenges to students, such as the need to learn a large new vocabulary to talk about brain function—specifically, to explain how "the 100,000 chemical reactions that occur every second and comprise our conscious experience affect our memories of the past, the interpretation of everyday behavior, even our personal identity."

Fernald says one of the difficulties in conceptualizing such a course is avoiding what he calls the "tyranny of coverage," by which he means "forcing students to know everything I know in some modified form." He characterizes the advantages and disadvantages of teaching in one's specialty: "the good news is that you know a lot about the subject; the bad news is that it's more difficult because you are likely to overwhelm students. Your need to impart everything you know may not match what they need to know."

According to former Professor of Electrical Engineering Charles Williams, there are many variables to take into account when imagining the students who will be in the course you are designing: not only the subject matter and level of the course, but "the hour, the season, the era." Although graduates are used to working independently and "animated by their career goals," he says, undergraduates are more of a "mixed bag," and their preparation for the course and their reasons for being there vary widely. Some students may be exploring a career or major; that is why, with undergraduates, "it is especially important to communicate the excitement of your subject and its relevance to the world at large."

Videotapes Related to Course Design Available at CTL

Russell Fernald, "Designing and Teaching a New Course," CTL: Award-Winning Teachers on Teaching, 1997.

Estelle Freedman, "Learning from Teaching," CTL: Award-Winning Teachers on Teaching, 1997.

Barbara Gelpi, "Creating Links between Technology and Teaching," CTL: Award-Winning Teachers on Teaching, 1997.

Diane Middlebrook, "Incorporating New Technologies," CTL: Award-Winning Teachers on Teaching, 1998.

Renato Rosaldo, "Conceptualization and Analysis: Structuring a Course," CTL Workshop Tape, 1985.

"Designing and Teaching Your Own Course," CTL TA Orientation Tape, 1991.

Williams describes one professor at Stanford who asks her students to fill out a questionnaire on their backgrounds the first day of class. In writing classes, a common first assignment is to take an inventory of students' previous writing experience. Asking them to write their first essay about their "history as writers," says one instructor in Writing and Critical Thinking, is a way to know whether they've gone beyond the classic "five-paragraph theme" to write organically (a process in which "the facts find their own form"), whether they have worked in peer groups to give and get feedback and, most importantly, whether they are accustomed to regularly revising their work.

Experienced teachers say that student attitudes are established in the first two weeks; therefore, nothing is more important than the way the course begins. As Fernald says, "Everything you do in the first weeks shapes students' attitudes. These early classes are extremely intense and reflect exactly how the course will be. Here is the chance to let students know how you feel about attendance, the importance of the reading, the material in general." Here also is the opportunity to demonstrate your beliefs about the role of lectures; the significance of discussions, readings, and assignments; and the relevance of the course to their lives.

Setting Course Objectives

There are many ways of determining and expressing course objectives, but Fernald, like most "architects" of a course, considers them first in relation to the students' educational needs. What should students learn from the

course? What content will they encounter and what learning experiences will they have? Joseph Lowman, author of *Mastering the Techniques of Teaching,* suggests making a large list of possible topics and skills and then eliminating the most dispensable using two criteria: "how essential the topics or skills are to the course as a whole and how interesting they might be to students."

Charles Williams lists three kinds of goals: "factual and theoretical *knowledge*, discrete, practical *skills*, and *growth in abilities* that generalize." He also suggests expressing objectives in terms of specific behaviors. For example, to acquire knowledge, students might "do" integrals or "describe" how something works, develop the skill to solve particular kinds of problems, and be able to generalize about parallel or analogous concepts. Among the general abilities students should develop, he mentions "working in groups, abstracting concepts, managing time, and developing various techniques for problem solving." He believes developing such skills "may influence a student's life the most" and so should be given attention in the planning stage.

Robert M. Diamond's model of development, which is deliberately flexible enough to be used in designing programs, curricula, or courses, calls for faculty to translate content- and discipline-specific objectives—expressed as competencies in certain categories such as scientific reasoning—into objectives specific to their course. These goals must be written in clear, concise terms "not open to misinterpretation" and must contain (1) "a verb that describes an observable action," (2) "the conditions under which this action takes place," and (3) "the level of acceptable performance." Diamond reproduces Robert Mager's list of observable actions and suggests writing objectives using these verbs, including "to write," "to recite," "to identify," and "to solve" (rather than "to know" or "to understand"). To illustrate an objective, Diamond gives course-specific ones such as this, from statistics: "When given two events, you will be able to determine if they are independent or if there is a relationship between them. . . . On the basis of this decision, you will be able to select and use the appropriate rules of conditional probability to determine the probability that a certain event will occur."

In the humanities, course goals are sometimes as broad as developing students' abilities to read, think critically, write, and speak—in short, to develop their capacities for interpreting and arguing. This, more than introducing particular subject matter, is the overriding objective of any introductory course, according to Jonathan Smith, writing in a sourcebook for religious studies. Philip Ivanhoe, Associate Professor of Philosophy, takes a similar tack, but in the case of courses in non-Western traditions, he believes the primary objective is the creation of a certain regard for philosophical and religious thought that is too easily viewed as "exotic," "mysterious," or "impenetrable." To accomplish this, Ivanhoe simply presents the material and his interpretation of it, rather than calling attention to how "different" and "alien" the material is. "The other-ness of the thought will be evident to the students if you portray your material accurately," he says; the value of studying such a different culture then inheres in the way it "makes strange" or defamiliarizes the "assumptions and preconceptions of one's own tradition. . . . One cannot raise certain questions about one's own beliefs until one sees them mirrored in another's eyes."

Expressing goals in terms of skills is common in writing-intensive courses such as Writing and Critical Thinking and courses designated by the department as fulfilling the Writing in the Major requirement. According to Claude Reichard, pedagogical consultant to the Writing in the Major program, and co-teacher of the pedagogy course for graduate students preparing to teach in Writing and Critical Thinking, by the end of the second course in the two-quarter WCT sequence, the student writer should be able to:

- Formulate and narrow a research problem
- Use a university library, including on-line facilities
- Collect, integrate, and analyze material
- Find and use primary and secondary sources and correctly document them
- Manage multiple voices when drawing on outside sources
- Formulate a thesis in a research paper
- Sustain an argument or chain of arguments in a paper of 10-12 pages

Determining the Class Format

Although making a decision about the format of a class—will it be lectures or will it concentrate on discussion?—seems straightforward enough, relying on traditional models often conflicts with specific pedagogical goals for the course. In thinking about the proper relation between the presentation of concepts and the activities that enable students to learn them, Fernald emphasizes the need to engage students consistently. "Most of us are more comfortable in the 'knowledge transfer' mode; our goal [in the Science Core] was to change it into the interactive mode," says Fernald. In the year spent planning the Core, during which fully half of the discussions were on pedagogical issues, the team set a firm goal of devoting 15-20 percent of class time to discussion. The overall goal was to give the class an interactive environment; the team then implemented the goal by brainstorming various frames the discussions would take. They decided to use questions and problem sets, with the goal of getting students to solve problems related to topics of the lectures.

Even in a class of over 300, as "Brain and Behavior" has become, discussion is still possible. The particular format decided on was the "breakout discussion"; when an issue comes up, the students break out into groups and think about the issue. Fernald gives the example of lecturing on the nervous system, specifically, on how neurons work. Here the breakout discussion relates the quantitative problem—the equation used to determine the amount of potassium involved—to a particular case in the

news: Dr. Kevorkian's injections of external potassium to help patients commit suicide. Thus Fernald tied an abstraction to a case students had heard about—a rather sensational one at that. He recommends introducing the pedagogical questions early, building them into the planning, and into the course content, rather than regarding them as separate, something to be added later.

Questions about Course Design

• *How will the critical concepts be organized for presentation over the quarter?*

The question facing the instructors of "Light" in the Science Core was how to teach the many new concepts involved and keep students "caught up" with the learning. A primary technique they used in planning the shape of the course is "concept maps"—which their team learned about from Jim Schneider, a graduate student in electrical engineering. Although concept maps are frequently taught to students to enable them to grasp complex material by diagramming relationships among various concepts (and are a tutoring tool in the sciences and in writing), Fernald uses them to diagram or visualize course content. To him, a concept map is a visual illustration of a particular arrangement of concepts that represents how one might introduce them. It thus varies depending on such factors as whether the instructor is starting at the micro level or the macro level; in a unit on the physics of water, for example, the concept map-maker could begin with the water molecule and diagram how it is affected by motion and heat to take different states and support living things. Or she could begin with living things in an ecosystem dependent on water.

As you plan, Fernald says, you are not only conceptualizing *what* you'll teach but *how*. Rearranging the terms helps you conceptualize your course content, frame things in new ways, across the whole quarter—how many concepts, what to begin with, and how to conclude. This is different from simply piling on terms in order to expand the students' knowledge base.

The "Light" teaching team has evolved a method of introducing material "just in time." Rather than devoting early weeks to explaining all the concepts that will be needed by the end of the quarter, they give crucial information when the students are ready to use it. According to Fernald, "delayed gratification is the usual model in science courses. You have to learn all the parts of light, and if you're lucky, the instructor will mention the laser at the end." He points to his co-teacher in the Core, Pat Burchat, who starts instead with the most recent techniques of the laser and uses that to arouse interest in learning about photons and electrons. When their interest is aroused and difficult concepts must be presented, she tells the class, "You're now going to need to know about quantum mechanics, and I have five minutes to tell you all about it." In Fernald's view, the memorable things the students observe in class "are the vehicles for motivating them to learn the technical principles of lasers."

Fernald finds it useful to explain his organizational philosophy to students—overall, in the syllabus, and in each lecture. He says that instructors often put guideposts for the next section of the course at the end of a lecture or series, signaling that the class will leave this level, go to another, and then come back to the first to reconcile or merge them. "Students are invariably grateful," he says, "and it's valuable for you to verbalize what you're trying to do in jumping from one lecture to the next."

Fernald also recommends making each lecture a question to be answered. This is not just a way to organize the material for students, but a check on whether you have thought deeply about the concept. "Is it necessary for them to understand, or is it something you happen to know a lot about, or have a cool slide to show?"

• *How can the syllabus convey course goals?*

The syllabus provides the opportunity to state at the outset not only the course objectives but your expectations of the students. The syllabus for "Brain and Behavior" includes the promise to show students how scientists study the brain, what they know and do not know, and how this knowledge will be relevant to the student's own life.

Writing-intensive courses usually show the relation between thinking and writing, reasoning and communicating. One syllabus in WCT describes the course objectives as "to challenge students to become not only stronger but more sophisticated thinkers and writers. The course will focus on the rhetorical strategies writers have used throughout history to 'argue,' that is, to solve problems, make decisions, and take stands, and then to persuade others to their point of view. The instructor and student writers will practice these strategies in order to write essays capable of convincing others of the correctness of the interpretation they make or the position they hold."

• *Should you use a textbook or compile a reader specific to the course?*

Because of the time it takes to gather materials and assure comprehensive coverage of course subjects, Wilbert McKeachie, author of *Teaching Tips*, cautions instructors to be wary of acting as their own textbook editor. He does concede that choosing one's own readings offers "flexibility, a variety of points of view, and an opportunity to maintain maximum interest" with a range of texts in a number of forms. The history teacher can provide primary documents or compile a case study of a particular event or issue; the literature teacher can gather different critical approaches to a novel or poem; and casebooks are handy for social science and business courses. The drawbacks of not adopting a textbook, however, are that the instructor has to do so much integrating of the material that there may not be enough time in the class period for active learning, such as problem solving and small-group discussion.

Fernald's advice is to ask yourself: am I going to lecture about what's in the text or about something that's not in the text? Fernald tries to provide students with

material that's not in the text, building on it in lectures and helping students think about what's in it. In short, he expands on the textbook, he does not simply reiterate it.

Planning in Teams and with Teaching Assistants

Team-Teaching

Because it requires coordination, any team-taught course is likely to be carefully planned. It is also likely to be thoroughly and creatively conceptualized because teachers preparing and teaching a course together find it a synergistic learning experience. As Fernald says about the Science Core, the process of teaching itself is enhanced as you develop a relationship with other people that is so solid and trusting that they can tell you your inadequacies in a constructive way. He urges team-teaching as one of the richest pedagogical experiences one can have, especially in unexpected ways. "Things I thought I knew how to teach well were transformed by having others around to watch," he says. He distinguishes between a course planned and conceptualized by all the instructors and one conducted by "tag-team teaching," where one guest-lectures but does not go back to the course to follow up on the learning.

Teaching with TAs

An important part of designing large courses or those with sections is planning an effective role for the TAs. Williams recommends involving them at the planning stage, asking them how they can most effectively contribute to the success of the course. Williams and Fernald offer these reminders to faculty working with TAs:

• Be clear about what you expect and why. Make reasonable demands. Allow sufficient time for them to handle unexpected changes.

• Give the TAs responsibility for dividing up the workload, e.g., for exams, grading, and knowing who does what.

• Exchange and interchange: Let TAs help with the teaching. Visit sections. Oversee grading to ensure consistency. Provide feedback, especially at the beginning. Get feedback in turn: they will know how students are doing, where they are confused, how the class is going. Provide situations where they can contribute easily.

• Encourage by precept and example. Everything you say and do about courses influences how TAs will feel.

• Model desirable attitudes toward teaching and students. Because graduate student instructors are socialized into the profession by observing and emulating the professors they work with in leading sections, labs, and discussion groups, it is important to let graduate students see your enthusiasm rather than dread—as Fernald says, "to radiate the right sense about your teaching." TAs must see teaching as an important part of the profession; they need to know that it can be an important intellectual experience just like their research can be." Lowman agrees, reminding faculty of the two possibilities of "exemplary" teaching. If faculty "never comment on the process of teaching except to complain," what TAs will learn is "that it does not matter how well one teaches, or that teaching is a necessary evil associated with an academic appointment." In courses where the professors share teaching methods they have tried and show enthusiasm for students, TAs are more likely to take teaching seriously and to want to follow in a good teacher's footsteps.

• Explain the philosophy behind your decisions so that the TAs can more easily decide which strategies to take as their own, or where they will depart in their own course planning and teaching practice.

Previous issues of *Speaking of Teaching* have addressed such related issues as the use of multimedia and online technology in designing courses, teaching with case studies, discussion leading, and active learning. Back issues are available on the Web at <http://www-ctl.stanford.edu/teach/speakmenu.html> and in CTL (on the first floor of Sweet Hall).

Discussion Leading—Some Tricks of the Trade (Fall 90)
The Agony and the Equity: Testing and Grading (Fall 92)
Do You Know Where Your Students Are? Classroom Assessment and Student Learning (Winter 93)
The Meeting of Minds and Machines: Teaching and Multimedia (Spring 93)
Active Learning: Getting Students to Work and Think in the Classroom (Fall 93)
Teaching with Case Studies (Winter 94)
Technology and Teaching: Using Online Technology to Break Classroom Boundaries (Fall 96)

Planning to Evaluate Learning

The purpose of testing is to discover how much students are learning, that is, how well you are meeting your objectives. Evaluation is significant to course design in that you must choose how you will assess learning as part of the process of deciding how to present the material. To function as an accurate index, a test must be something that the students can anticipate and prepare for; it must be clear; it should be challenging but not impossible or tricky; and its questions should require students to analyze problems and synthesize concepts rather than just perform mechanical operations.

Examinations, according to Joseph Goodman, Professor of Electrical Engineering, "should cover a broad spectrum of material" and "be representative of the course as a whole." Furthermore, students have a right to know when the exams will come and what type they are, how much they will cover, whether they are cumulative, and so on. Fernald and Goodman advise making old exams

accessible to everyone, since some students will have them. The best exams, learning experts agree, are a learning experience. A corollary principle is that frequent testing enhances learning.

Fernald's most important advice concerning assessment is to provide a study guide. "A well-designed study guide reiterates everything you've talked about in the class, so that the student who takes it seriously can do very well. Almost as important, you are giving them a chance to hear from you what you're going to put on the exam. They now feel the exams are fair because you have given them the tools to succeed on them." For example, the "Brain and Behavior" study guide has the complete vocabulary on the back. If a study guide is prepared as part of the planning for the course, perhaps in conjunction with TAs, it will serve as a reminder of what material must be covered during the course.

Using Feedback from Students to Evaluate Design

Because the most helpful feedback often comes from the students you had in mind when you imagined the course—that is, the best students—Fernald recommends writing letters to the top ten or fifteen students, for they are the ones getting the most out of it. If you deal only with those having problems, such as those who contest their grade the next quarter or the next year (usually those who fall outside the distribution), you may forget those for whom the course is working, and working well. This strategy of getting to know students who are in love with the class, who change their major or their lives because of it, keeps you aware of the importance of what you're doing.

Fernald also recommends having extended office hours to reach out to these students and taking students out to lunch to get to know them. "They will give you a lot of insights about the class, too," he adds. The new School of Humanities and Sciences teaching evaluation forms (which Fernald helped to devise) ought to help with feedback. He advises giving students plenty of time to fill them out. "Tell them they are important to you, and that you will pay attention to them."

Anyone who has taught the same course more than once acknowledges that it is different each time you teach it because the students are different. Fernald says that he makes a number of changes each time he teaches a course, but he is sure to do it based on the students' response. (See *Speaking of Teaching*, Fall 1997, "Using Course Evaluations to Improve Teaching.")

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