Faust, J. L., & Paulson, D. R. (1998). Active learning in the college classroom. *Journal on Excellence in College Teaching, 9* (2), 3-24.

Active Learning in the College Classroom

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The authors present a catalog of active-learning techniques aimed at fostering student learning in the context of a lecture course. The activities they discuss range from listening practices, which require students to absorb what they hear, to short writing exercises, in which students react to lecture material, to complex group exercises, in which students apply course material to "real life" situations and/or new problems. In addition to their review of active-learning techniques, the authors discuss some of the potential barriers to implementing active learning and suggest solutions. Finally, they add their own insights about how these techniques have worked—and not worked—in their classes. Because the authors represent both the natural sciences and the humanities, their success with these methods should be encouraging to faculty from different disciplines considering using active learning in their own courses.

The past decade has seen an explosion of interest among college faculty in the teaching methods variously grouped under the terms *active learning* and *cooperative learning* (see, for example, Bonwell and Eison, 1991; Meyers and Jones, 1993; Silberman, 1996; Johnson, Johnson, and Smith, 1991a). A large amount of research attests to the benefits of active learning (see, for example, Hake, 1998; Sokoloff and Thornton, 1997; Wright and others, 1998). However, there remains much misunderstanding and mistrust of the pedagogical movement behind the research. The majority of college faculty still teach their classes in the traditional lecture mode. Some of the criticism and hesitation concerning active and cooperative learning seems to originate in the belief that these techniques are intended to be alternatives to, rather than enhancements of, lectures. We will counter this either-or misconception by surveying a wide vari-

ety of active-learning techniques that can be used to supplement rather than replace lectures. We do not advocate the complete abandonment of lecturing; both of us still lecture for at least half of a given class period. We believe that the lecture is a very efficient way to present information, but that using lecture as the sole mode of instruction presents problems for both the instructor and the students.

Active learning is, in short, any learning activity engaged in by students in a classroom other than listening passively to an instructor's lecture. As we will show below, this includes everything from listening practices that help students absorb what they hear, to short writing exercises in which students react to lecture material, to complex group exercises in which students apply course material to "real life" situations and/or new problems. The term *cooperative learning* covers the subset of active-learning activities that students do in groups of three or more, rather than alone or in pairs. Cooperative-learning techniques generally employ formally structured groups of students assigned to complex tasks, such as multiple-step exercises, research projects, or presentations. Cooperative learning is to be distinguished from the more general term *collaborative learning*, which refers simply to any situation in which groups work together. Cooperative learning uses groups to work toward a common goal with positive interdependence, individual accountability, and heterogeneous groupings (Cooper & Mueck, 1990). Active-learning techniques, then, are those activities that an instructor incorporates into the classroom to foster active learning.

In this article, we provide a catalog of active-learning strategies, illustrated, where appropriate, with examples from our own courses. Generally, the list is in order of increasing complexity, from the first group of strategies, "exercises for individual students," which require minimum time and effort—both in preparation and in practice—of students and instructor, to the final group, "cooperative-learning strategies," which involve the greatest commitment of time and energy. In addition to surveying various techniques of active learning, we address some of the obstacles to implementing active-learning methodologies in the classroom and suggest strategies for overcoming them. Finally, we present the results of our empirical research into the effectiveness of these techniques. We have found that they produce overwhelmingly positive results, both in increased academic achievement and in enhanced social and psychological benefits to students. We hope that our experiences will be encouraging to faculty who may be considering active-learning techniques for their own classes.

Exercises for Individual Students

Although some innovative instructional techniques increase the instructor's preparation time and/or the time required to manage and grade projects, many of these techniques require very little additional time (see, for example, King, 1993; Johnston and Cooper, 1997; Meyers and Jones, 1993; Silberman, 1996). The exercises that follow are intended to increase students' active participation in the course without a significant investment of the instructor's time or energy. Because these techniques are aimed at individual students, they easily can be used without interrupting the flow of the class. These exercises are particularly useful for providing the instructor with feedback concerning student retention and understanding of the material. Some of them (especially affective response and the daily [or weekly] journal) are designed to encourage students to apply course concepts to wider contexts as well as to explore their own attitudes and values. Finally, these exercises can provide an effective means of communication between instructor and students—particularly in large lecture classes, where it is difficult to establish a rapport with students.

Clarification Pauses. This is a simple technique aimed at fostering "active listening." Throughout a lecture, particularly after stating an important point or defining a key concept, the instructor stops talking, lets the material sink in, and then (after waiting a bit) asks if anyone needs to have anything clarified. The instructor might also circulate around the room during these pauses to look at student notes, answer questions, and so forth. Students who might never ask a question in front of the entire class are more likely to ask questions as the instructor moves about the room. Pausing to let material sink in helps to avoid what some researchers identify as the central problem of the standard lecture format, that "information passes from the notes of the professor to the notes of the student without passing through the mind of either one" (Johnson, Johnson & Smith, 1991b, p. 91).

One-Minute Paper. Originally reported by Angelo and Cross (1993), this technique has been adapted for use in virtually every discipline (see, for example, Dorroh, 1993; Fishman, 1997; Kloss, 1993; Ludwig, 1995; Morrissey, 1982). It is a highly effective method for checking student progress and for providing a consistent means of communicating with students. To implement this method, the instructor simply stops class a few minutes early (or pauses at some point during a lecture), poses a specific question (for example, "What was the main point presented in today's class material?"), and gives students one (or perhaps two—but

not many more) minute to respond. Students' responses tell the instructor whether or not they view the material in the way he or she envisioned. Depending on an instructor's objectives, students may submit their responses anonymously or with their names on them. Anonymity may encourage otherwise reticent students to voice concerns or raise questions, but it will not foster direct communication between students and the instructor. Further, it has been argued that allowing anonymous submissions actually detracts from active engagement in the exercise because students may perceive that they have little to gain by applying themselves to the task (Harwood, 1996).

Muddiest (or Clearest) Point. This variation on the one-minute paper is specifically designed for determining gaps in student comprehension (Angelo & Cross, 1993). The instructor requests a one-minute written response to the question "What was the 'muddiest point' in today's lecture?" or "What concept do you find most difficult to comprehend?" The question may be more specific. Because the instructor collects the responses immediately and can read them before the next lecture period, he or she has the opportunity to make teaching adjustments in response to the students' needs much sooner than would be possible otherwise.

Affective Response. This is another variation on the one-minute paper theme, but in this case the instructor asks students to report their reactions to some facet of the course material—for example, to note their emotive or evaluative response. Obviously, this approach is limited to those subject areas in which such questions are appropriate (one would not, for instance, ask about students' affective response to a chemical structure or to Hume's problem of induction!). However, affective response can be a quite useful starting point for courses with significant practice components or for those that deal with ethical issues, particularly as a precursor to theoretical analysis. For example, the instructor might ask students what they think of Dr. Jack Kevorkian's activities before presenting what various moral theorists would make of them; or, he or she might present students with a case study related to their individual fields and have them analyze a particular character's response to events. By having several views on the table before a theory is presented, students will have a context in which to place the material. This is also a good way to begin class discussion of topics about which the general public often has views contrary to current thinking among a discipline's experts, such as the mind/body problem in philosophy or the creationism versus evolutionary biology debate.

Student Response to a Demonstration (or Other Teacher-Centered Activity). After a classroom or laboratory demonstration, the instructor

asks students to write a paragraph that begins with the phrase "I was surprised that . . . ," "I learned that . . . ," or "I wonder about. . . ." This lead allows students to reflect on what they actually got out of the teacher's presentation. It also helps students realize that the day's activity was designed for more than just entertainment.

Daily (or Weekly) Journal. This strategy combines many of the advantages of the five techniques above while allowing for more in-depth discussion of or reaction to course material. The journal is an effective tool for motivating students to apply course concepts to their own life experiences and to explore course content in broader contexts, including public debate. The only disadvantage of this approach is that the feedback to the instructor is not as "instant" as with the one-minute paper and other assignments that are collected the day of the relevant lecture. But what it loses in immediacy, the journal makes up for in complexity and the opportunity for students to formulate careful, well-crafted responses. Instructors can have students share their journal entries with each other so that they may get peer feedback on their entries before the instructor reads them (Cooper, 1986). Finally, journal assignments may be combined with other exercises, such as library research, newspaper reading, or laboratory exercises (see, for example, Cropp, 1980; Reinertsen and DaCruz, 1996; Fisher, 1996). One example of a journal topic (from a scientific reasoning course) is this: "Find a report of a scientific study from either a newspaper or a popular (non-science) magazine. What is the reported conclusion of the study? Does the study establish a correlation or a causation relation? Explain your response."

Reading Quiz. Active learning depends on students coming to class prepared. In addition to being an effective means of encouraging students to read assigned material, the reading quiz can be used to measure student comprehension of readings, thus providing the instructor with evidence of students' level of sophistication as readers (Mazur, 1996, 1997). By asking the same sorts of questions on several reading quizzes, instructors can guide students regarding what to look for when reading assigned texts. For instance, if reading quizzes in an English literature class consistently include questions such as "What color were Esmerelda's eyes?" students will learn that it is the details that count. On the other hand, questions such as "What reason did Esmerelda give for murdering Sebastian?" highlight issues of justification. If the goal is to instruct and not merely to coerce, quiz questions must be carefully constructed so that they identify both which students have read the material (for the instructor's benefit) and what is important in the reading (for the students' benefit). Using straightforward questions based directly on the class reading assignments for each day, Paulson (1999) has found

a correlation ($r = \sim 0.8$) between the total points on the reading quizzes and the total course points.

Questions and Answers

Most college faculty use some form of the Socratic method as a way of prodding students and instantly testing comprehension. This technique, in its original format, involves the instructor testing students' knowledge (of reading assignments, lectures, or, perhaps, applications of course material to a wider context) by asking questions during the course of a lecture. Typically, the instructor presents a particular student with a question. If the student cannot answer the question immediately, the instructor chooses another student (and then another, if necessary) until he or she receives the desired answer. This method of questioning has several serious drawbacks. It favors only a small segment of the class (that percentage of students who can answer practically any question thrown at them). In addition, only the chosen student must actively attempt to answer the question. Furthermore, once a student has answered a question, he or she may not continue to pay close attention, knowing that it will be a long time before the teacher returns to him or her for a second question. In spite of these limitations, we feel that the Socratic method is an important and useful classroom technique. There are simple ways of improving questioning techniques that increase student involvement and comprehension. The following variations on the method enhance its effectiveness while avoiding some of the pitfalls. These techniques are aimed at enabling each student in the classroom to "own" the question and to try actively to answer it.

Wait Time. Rather than immediately choosing a student to answer a question that he or she has presented, the instructor waits a short time (15 seconds or so) before calling on someone (Rowe, 1980; Schaible & Rhodes, 1992). It is important for the instructor to insist that students not raise their hands or shout out the answer before he or she gives the okay. This discourages the typical scenario in which the students in the front row all immediately volunteer to answer the question and everyone else sighs in relief. The wait time gets all students thinking actively about the question rather than allowing them to rely passively on those students who are fastest out of the gate. When the wait time is up, the instructor asks for volunteers or randomly picks a student to answer the question. When students get into the habit of waiting after questions are asked, more of them will get involved in the process.

Student Answers. Many college faculty typically rephrase an answer

that a student has just given. However, this practice encourages students not to pay attention to their peers because they know the professor will give the desired answer to the question. Instead of rephrasing a student's answer, the instructor can ask an additional question, state the question for which the student's answer would be correct, or ask for input from other students. This approach is much more effective than the instructor's simply giving the correct answer or rephrasing the student's answer.

Student Summary of Another Student's Answer. Many students hear little of what their classmates have to say, waiting instead for the instructor either to correct or repeat the answer. In order to promote active listening, after one student has volunteered an answer to the question, the instructor can ask another student to rephrase, in his or her own words, the student's response. Having students summarize or repeat each others' contributions to the course fosters active participation by all students and promotes the idea that learning is a shared enterprise. Confronted with the possibility of being asked to repeat a classmate's comments, most students will listen more attentively to each other.

The Fish Bowl. In this technique, the instructor gives students index cards and asks them to write down one question concerning the course material. They should be directed, for example, to ask for clarification of some aspect of the material that they do not fully understand; or, perhaps, to ask about applying course material to practical contexts. At the end of the class (or at the beginning of the next class if the question is assigned for homework), students deposit their questions in a fish bowl. The instructor then draws several questions out of the bowl and asks the class to answer them. Instructors can edit the questions or skip ones that are not appropriate for what they are trying to accomplish. Then instructors can invite students whose questions were not selected to see them after class or during office hours to have their questions answered.

Quiz/Test Questions. Students become actively involved in creating quizzes and tests by constructing some or all of the questions. This exercise may be assigned for homework and evaluated itself. By asking students to contribute exam questions, instructors encourage them to think more deeply about the course material, explore major themes, compare the different views presented, make applications, and demonstrate other higher order thinking skills. The students' questions may be used on exams, as the basis of review sessions, and as models of the most effective questions. Further, instructors may ask students to discuss the merits of the questions submitted. Students might discuss the relative merits of two different questions on the same material, including degree of difficulty, effectiveness in assessing learning, scope, and so forth.

Discussing sample exam questions will significantly increase students' engagement with the material.

Immediate-Feedback Techniques

Immediate-feedback techniques are designed to give the instructor some indication of students' understanding of the material presented during the lecture. The activities provide formative, rather than summative, assessment of students' understanding. Formative assessment is evaluation of the class as a whole in order to provide information for the benefit of the students and the instructor, but the information is not used as part of the course grade. Summative assessment is any evaluation of student performance that becomes part of the course grade. For each feedback method he or she presents, the instructor stops at appropriate points to give quick tests on the material. In this way, the instructor can adjust the lecture in mid-course, slowing down to spend more time on the concepts students find difficult or moving more quickly to applications of concepts of which students have a good understanding.

Finger Signals. This method provides instructors with a means of testing student comprehension without the waiting period or grading time required for written quizzes. The instructor asks students questions and instructs them to signal their answers by holding up an appropriate number of fingers immediately in front of their torsos where their peers cannot see them (this makes it impossible for students to "copy" from each other, thus committing them to answer each question on their own). For example, the instructor might say, "one finger for 'yes,' two for 'no,'" and then ask an appropriate question. Or the instructor might prepare multiple-choice questions for the overhead projector and number the answers 1 through 5, asking students to respond with finger signals. In very large classes, students can respond by using large cardboard signs with numbers written on them or different-colored cards (Meltzer & Manivannan, 1996). This method allows instructors to assess students' knowledge literally at a glance.

Flash Cards. A variation on the finger signals approach, this method tests students' comprehension through their responses to flash cards held by the instructor. It is particularly useful in disciplines that utilize models or other visual stimuli, such as chemistry, physics, or biology. The instructor holds up a card with a diagram or reaction written on it and then asks students to respond to a question with finger signals. Paulson (1999) has found this technique particularly useful when discussing the acidity of organic acids.

Quotations. This is a particularly useful method of testing students' understanding when they are learning to read texts in order to identify authors' viewpoints and arguments. Students read representative advocates of several opposing theories or schools of thought and define and discuss the relevant concepts in class. Then the instructor displays a quotation on the overhead projector by an author whom students have not read in the assigned materials and asks them to figure out what position that person advocates. In addition to testing students' comprehension of the material presented in lecture, this exercise develops critical-thinking and analysis skills. It would be very useful, for example, in discussing the various competing evolutionary theories.

Critical-Thinking Motivators

Sometimes it is helpful to get students involved in discussing or thinking about course material either before presenting any theory in lecture or after presenting several conflicting theories. In the first case, the purpose is to generate data or questions prior to mapping out the theoretical landscape; in the second case, the students learn to assess the relative merits of several approaches.

The Pre-Theoretic Intuitions Quiz. Students often dutifully record everything the instructor says during a lecture and then ask at the end of the day or the course, "What use is any of this?" or "What good will this course do for us?" To avoid encountering such questions, and to get students interested in a topic before lecturing, an instructor can give a quiz aimed at getting students both to identify and assess their own views. For example, in an introductory ethics course, a True-False questionnaire, to be administered on the first or second day of the course, could be designed to start students thinking about the lecture topic (for instance, moral theory). The quiz could include statements such as "There are really no correct answers to moral questions" and "Whatever a society holds to be morally right is in fact morally right." After students have responded to the questions individually, they can compare answers in pairs or small groups and discuss the ones on which they disagree. This technique may also be used for a pre-/post-lecture comparison of students' knowledge of the subject matter. The well-known "Force Concept Inventory" (Hestenes, Wells, & Swackhamer, 1992), developed to measure understanding of force and motion, is a good example.

Puzzles/Paradoxes. One of the most useful means of ferreting out students' intuitions on a given topic is to present them with a paradox or a puzzle involving the concept(s) at issue, and then to have them struggle

towards a solution. Requiring students to "work it out" without relying on an authority's position increases the likelihood that they will be able to assess theories critically when presented with them. For example, students in a course on theories of truth might be asked to assess the infamous "Liar Paradox" (with examples such as "This sentence is false") and to suggest ways in which such paradoxes can be avoided. Introductory logic students might be presented with complex logic puzzles as a way of motivating truth tables, and so forth. In scientific fields, instructors can present experimental data that seem to contradict parts of a theory just presented, or they may use examples whose features seem to support two opposing theories.

Share/Pair

Putting students in pairs provides many of the advantages of group work. A recent meta-analysis of 383 published reports on small-group learning in college science, math, engineering, and technology classes showed that small-group learning promotes greater student achievement, increases retention in courses, and promotes favorable attitudes toward the course material (Springer, Stanne & Donovan, 1998). Students have the opportunity to state their own views, to hear from others, to hone their argumentative skills, and so forth, without the administrative requirements of group work (time spent assigning people to groups, class time used for getting into groups, and so on) (Shakarian, 1995). Further, working in pairs makes it virtually impossible for students to avoid participating, thus making each person accountable.

Discussion. In discussion, students pair off and respond to a question either in turn or as a pair. This method easily can be combined with other techniques, such as those discussed under "Questions and Answers" or the "Critical-Thinking Motivators" discussed above. For example, after students have responded to a list of true-false statements, they can be asked to compare their answers with their partner's and to discuss the statements on which they differed. In science classes, students can be asked to explain how some experimental data support a theory that the instructor has just discussed. Generally, this approach works best when students are given explicit directions, such as "Tell each other why you chose the answer you did."

Note Comparison/Sharing. One reason that some students perform poorly in classes is that they do not have good note-taking skills. That is, although students may listen attentively, they do not always know what to write down, or they may have gaps in their notes that leave them

bewildered when they go back to the notes to study or write a paper. One way to avoid some of these pitfalls and to have students model good note taking for each other is to have them compare notes occasionally. After covering a crucial concept, the instructor might stop lecturing and have students read each other's notes, filling in the gaps in their own note taking. This activity is especially useful in introductory courses or in courses designed for non-majors or special admissions students. When students see the value of supplementing their own note taking with others' notes, they are more likely to continue the practice outside of class time.

Evaluation of Another Student's Work. This method works well when students have completed an individual homework assignment or short paper. On the day the assignment is due, students submit one copy to the instructor and one copy to a partner. Partner pairs may be formed just for the day or assigned for the entire term. Each student offers critical feedback on his or her partner's work, standardizes or assesses the partner's arguments, or corrects mistakes in problem solving or grammar. Peer evaluation can be a particularly effective way to improve student writing. However, students need to be given specific instructions on what to look for in the work they are assessing. In a course that Paulson teaches entitled Writing for Chemists, for example, students receive a Group Editing Guide, which helps them to focus on the important features in each section of a paper. Without these detailed instructions, students tend to make rather general and not very useful comments. Students also can benefit from assessing an anonymous paper or a paper from a previous class selected by the instructor.

Cooperative-Learning Strategies

For more complex projects, where many heads often are better than one or two, instructors may want to have students work in groups of three or more. The kinds of exercises included under the rubric of cooperative learning all utilize small groups in which three to five students work together toward a common goal. Cooperative-learning groups can be divided into three distinct categories: informal cooperative groups, formal cooperative groups, and base groups (Johnson et al., 1991a). Which type of cooperative group an instructor utilizes will depend on course objectives, class time available to devote to the project, availability of students outside of class time, and course material.

The simplest type of cooperative-learning group is the informal group, which can be put together on the spot. If, for example, students are hav-

ing a particularly difficult time with a problem posed or a concept being covered in lecture, the instructor may opt to pause and have students get into small groups to go back over their notes to define the concept or work out the problem. Because informal cooperative groups can quickly and easily be formed or disbanded, they are convenient for in-class work (Giddon & Kurfiss, 1990; Johnson & Johnson, 1994a).

For more complex tasks that require longer amounts of time and/or require students to produce reports of their results, formal cooperative-learning groups are more appropriate (Sharan & Sharan, 1994). This second type of group is generally more structured, with the instructor determining the size and composition of the group according to appropriately chosen criteria (for instance, common interests, levels of mastery of the material). When formal groups will be working together over time or on complex projects, it is generally better to form heterogeneous groups in terms of gender and ethnicity as well as academic performance (Cooper et al., 1990; Smith, 1996). Once the groups are formed, the instructor assigns them a task to complete together, with the instructor monitoring their progress, trouble shooting, and intervening when necessary.

Finally, instructors may wish to utilize a third type of cooperative group, the base group (Slavin, 1994). Base groups are formed at the beginning of the term and remain intact throughout the course, providing students an opportunity to develop long-term, mutually supportive relationships. Base groups may be used in conjunction with or instead of the other two types of groups. As some of the strategies below illustrate, classes can be structured to include a combination of the three group types.

The following is a short list of the different ways in which small cooperative-learning groups may be used; for detailed descriptions of cooperative-learning projects and for examples of cooperative-learning groups that have been adapted for specific disciplines, there is a rapidly growing literature on the subject (see, for example, Angelo and Cross, 1993; Cooper and Robinson, 1998).

Active-Review Sessions. In the traditional class review session, the students ask questions and the instructor answers them. Students spend their time copying down answers rather than thinking about the material. In an active-review session, the instructor poses questions, and the students work on them in cooperative-learning groups (either informal or base groups can serve this purpose). Then the instructor asks students to share their solutions with the class, and all students discuss any differences among their proposed answers. The ensuing discussion can be guided according to the questions and answers techniques outlined above.

Work at the Blackboard. In many problem-solving courses (such as mathematics, logic, or critical thinking), instructors tend to review homework or teach problem-solving techniques by solving the problems themselves. Because students learn more by doing than watching (Springer et al., 1998), this is clearly not the optimal scenario. Rather than illustrating problem solving, instructors can have students work out the problems themselves by asking them to go to the blackboard in small groups. Cooperative groups encourage discussion of problem-solving techniques ("Should we try this?") without embarrassing students who have not yet mastered the required skills. If there is insufficient blackboard space, students can still work out problems as a group by using paper and pencil, small dry-erase boards, or even computers if the appropriate software is available.

Concept Mapping. A concept map is a way of illustrating the connections that exist between terms or concepts covered in class (Novak, 1990; Novak & Gowin, 1984). Students brainstorm to generate a list of facts, ideas, or concepts for a particular topic and then draw lines connecting related items. Above each line students write the nature of the relationship between the items. Because most of the terms in a concept map have multiple connections, students must identify and organize information to establish meaningful relationships between the pieces of information. A concept map is an effective means to show students how the many concepts covered in a typical course are connected. Although individuals as well as groups of students can do concept mapping, the maps produced in groups are usually much more detailed than those produced by individual students.

Visual Lists. In this technique, students make a list of opposing points or arguments on paper or on the blackboard. Students typically can generate more comprehensive lists working in groups than they can alone. This method is particularly effective when asking students to compare views or to list the pros and cons of a position. One technique that works well with such comparisons is to have students draw a 'T" and label the left- and right-hand sides of the crossbar with the opposing positions (or "Pro" and "Con"). Students then list everything they can think of to support these positions on the relevant side of the vertical line. Once students have generated as thorough a list as they can, the instructor asks them to analyze the lists by asking questions that are appropriate to the exercise.

Role Playing. In role playing, students act out a situation or incident. By doing so, they gain a better understanding of the concepts and theories being discussed in class. Role-playing exercises can range from thought experiments for individuals (for example, "What would you do if a Nazi came to your door, and you were hiding a Jewish family in the

attic?") to complex group interactions. Depending on the time and resources available, role playing might take the form of a play. For example, students studying ancient philosophy might recreate the trial of Socrates.

Panel Discussions. Panel discussions are particularly useful as a way to include the entire class when students give class presentations or reports. The instructor assigns student groups to research a topic and prepare a panel presentation on it (this technique may readily be combined with the jigsaw method outlined below). Each panelist then makes a very short presentation before the floor is opened to questions from the audience. The key to this method's success is to choose topics carefully and to give students sufficient direction to ensure that they are well prepared for their presentations. Instructors also may want to prepare the classroom audience by assigning students various roles. For example, if students are presenting the results of their research into a medical ethics problem such as euthanasia, some of the other students might take on the roles of clergy, patients'-rights advocates, hospital officials, and so forth.

Debates. Actually a variation on the panel discussion, formal debates provide an efficient structure for class presentations when the subject matter easily divides into opposing views or pro/con considerations. The instructor assigns students to debate teams, gives each team a position to defend, and asks the teams to present arguments in support of their position. First, one team presents its arguments. The opposing team then has an opportunity to rebut the arguments, and, time permitting, the original presenters respond to the rebuttal. This format is particularly well suited to courses that stress the development of argumentation skills in addition to the mastery of content (Seech, 1984; Johnson & Johnson, 1994b).

Games. Some will scoff at the idea of playing games in a university setting, but in certain situations there simply is no better instructional tool. For example, a game that simulates social inequalities and forces students to "live" at a lower socioeconomic position will dramatize aspects of social and political reality that cannot be transmitted via lecture (Groves, Warren, & Witscher, 1996). Or in classes in which it is essential to build on a set of facts, the use of crossword puzzles, *Jeopardy*™-like games, and the like can be a highly effective way to review material before proceeding further.

Jigsaw Group Projects. In jigsaw projects, each member of a cooperative-learning group becomes "specialized," mastering a discrete part of the subject matter required to complete the project. He or she thereby possesses knowledge critical to the rest of the group. There are generally

four stages in the jigsaw process (Clarke, 1994; Marcus, 1998). First, the instructor organizes students into heterogeneous home groups (if the instructor has assigned students to base groups during the term, the base group may constitute the home group for a given project). Each member of the home group is assigned or chooses a part of the subject matter to be explored. For example, if the project requires applying several moral theories to a case study, each student in the home group is assigned to become an expert on a particular moral theory. In the second stage, students re-form into focus groups centered on their selected topics. In our hypothetical example, several students from different home groups who were designated as experts on Kant's moral theory would group together to explore, clarify, and write down the main ideas of that theory. In the third stage, these focus groups disband, and the original groups re-form. The home groups now include an "expert" on each moral theory subtopic. The experts report their findings to the rest of their home group, and the group discusses the issues in depth. The fourth and final stage of the project requires the group to apply this information. In the example above, each group could determine the moral status of an action portrayed in a case study according to the various moral theories they have mastered.

Overcoming Obstacles to Active Learning

In our discussion of active-learning techniques, we have favored a comprehensive survey over a more detailed discussion of any one strategy. We hope that the breadth of this list establishes our claim that active learning can be incorporated into any course, no matter the level of instruction or the discipline. But we have found that while many faculty are aware of active- and cooperative-learning techniques, they are reluctant to use them in their classes. Why are many faculty reluctant to use these instructional techniques?

Foremost among the obstacles perceived by these faculty seems to be the "coverage problem"—that an instructor cannot cover as much material in a course incorporating active-learning techniques as in a course using exclusively lecture. A growing body of evidence suggests that students learn and retain more information when they are asked to engage it actively (see, for example, Springer and others, 1998). However, weighing content coverage against active learning creates a devil's bargain: Either teach more material and have students learn less, or teach less material and have students learn more of it. Little purpose is served by the first choice. Students always will be better educated if we expose

them to slightly less content but require them to engage the material. We all have had the experience of students coming into our classes appearing to have little knowledge of what was covered in their previous courses. The material was "covered," but the students did not learn it. Thus, even in courses in which there are mandates on the amount of material to be covered, students are likely to be better prepared for successive courses if they are actively engaged in learning the material. Finally, the instructor need not cover all of the material during class time; students can be held responsible for covering some of it on their own.

A second common objection to incorporating active learning into existing courses is that it takes too much time to prepare an active-learning course (particularly when an instructor has taught the course before and already has lectures prepared). We must agree that the preparation time will increase the first time an instructor teaches a course using active-learning techniques. However, once he or she has developed active-learning strategies for a given course, they can be used each time the course is taught (and the strategies can be adapted for other courses as well). Also, some active-learning techniques require little or no added preparation time. For example, the "Exercises for Individual Students" we discussed above require only the time it takes to think of appropriate quiz or journal questions (and, perhaps, the time to prepare overhead projector slides), and the techniques under "Questions and Answers" require no additional preparation time. Some of these strategies merely require that instructors develop new teaching habits, not that they increase the time they devote to teaching. It is true, however, that the more complex strategies appearing toward the end of our list (such as some of the cooperative-learning group projects) will add considerably to the time needed to prepare courses. Thus, if time is of the utmost concern, instructors will want to choose from the techniques toward the beginning of the list.

A third reason that many faculty avoid using active-learning techniques is that they are comfortable lecturing and they find innovative instructional techniques intimidating. Chief among their concerns is the fear of "losing control" of the class. In addition, some faculty may avoid incorporating active-learning strategies into their classrooms because they think that students will react negatively. A complaint we often hear is, "I tried active learning, but my students didn't like it." Indeed, most of us have had the experience of attempting to initiate class discussion and being faced with silence. These two issues are related, for both students and faculty tend to be comfortable with what they are trained to do. Thus, as long as faculty lean primarily on lecturing, students will expect to sit and listen.

It is worth noting that the "higher up" instructors go, the more we tend to utilize complex active-learning strategies, with graduate courses generally devoting more class time to discussion and problem solving than introductory courses. Ironically, we find that in some disciplines, senior-level and graduate students are reluctant to accept active-learning strategies because they became so used to the lecture format at the lower levels. If we expect our graduate students to embrace active learning, then why should we limit our introductory students to merely hearing about it?

Although some students may be most comfortable with the lecture format, it is not necessarily the most beneficial teaching style for all students. Recent studies on student learning have revealed that not all students learn material in the same way, but instead have different learning styles (Claxton & Murrell, 1987; Schmeck, 1988). When we present information exclusively in one style, such as lecture, we are discriminating against a significant portion of the class that may learn best with another style. In addition, once students leave college, they will need to process information presented to them in a variety of ways. Thus, using the techniques we have presented above *along with* lecture provides a better way to reach all of the students in the classroom and better prepares them for the workplace (Felder, 1993).

Finally, using strategies that aim to include students in the learning process need not become the free-for-all that faculty new to these alternatives may fear it will. It is true that instructors cannot simply stop lecturing, offer students the floor, and expect fruitful discussion to follow. By using discrete exercises with clearly articulated goals, however, instructors can guide students toward a deeper understanding of the material presented. And by beginning with low-risk methods and gradually proceeding to higher risk activities, hesitant instructors can ease their way toward successful active-learning classes.

Conclusions

University faculty sometimes feel that although active/cooperative learning may work in some fields, it probably will not work in their field. The fact that an organic chemistry professor and a philosophy professor both can successfully employ the techniques described in this paper speaks well for the universality of this teaching pedagogy. We both have seen astonishing results using active learning in the classroom. In a year-long (three-quarter) organic chemistry sequence for majors taught by Paulson during the period 1984-1993 using the classical lecture method, the overall retention rate, which is defined as the number of students

receiving grades of A, B, or C divided by the number of all grades given (A, B, C, D, F, I, W, and U), was 0.38 (1100 total students). During the period 1994-1999, when Paulson changed the mode of teaching to incorporate active learning, the overall retention rate increased to 0.75 (500 total students). Furthermore, the students who were taught in the active-learning mode did much better in the laboratory sections of the course in terms of both average GPA (2.73 vs. 2.26) and retention rate (.97 vs. .72) (Paulson, 1999).

A comment we often hear is that although cooperative learning probably helps improve the understanding of average students, it is unfair to the "A" students, who must teach the material to the other members of their group. As every teacher knows, one's understanding of a topic is vastly improved when one must explain it to others. Paulson has anonymously surveyed all of the "A" students in three consecutive organic chemistry classes and found they overwhelmingly agreed that the teaching aspect of cooperative learning helped them to understand the course material.

In addition to its academic advantages, active learning has been shown to produce numerous social and psychological benefits. A recent review of research on cooperative learning found that it boosts development of critical-thinking skills and fosters social interdependence and support among students (Slavin, 1996). Further, when compared with more traditional competitive or individualistic learning methods, cooperative learning improves students' attitudes toward their subject area, improves relationships between students, and improves student retention (Johnson & Johnson, 1981, 1989). Cooperative-learning methods can be particularly beneficial in larger classes (Frederick, 1987), which are increasingly common at the introductory level. As class size grows, it is often a challenge to include a significant number of students in class discussion; also, the instructor's ability to monitor student understanding seems to be inversely proportional to class size. Using small cooperative-learning groups is an effective way to overcome these difficulties (see, for example, Weimer, 1987; Cooper and Mueck, 1990).

Students themselves reinforce these claims. In the two introductory philosophy courses that Faust teaches, students overwhelmingly supported the use of cooperative-learning groups. Ninety-one percent of 700 students from five different large lecture sections said that they both enjoyed group projects and learned more than they would have otherwise. In response to the open-ended question "What were the positive aspects of using cooperative-learning groups?" students invariably listed social/psychological benefits. For example, in one large lecture section of 125 students, 57% of respondents noted the opportunity to hear dif-

ferent opinions and ideas, 25% cited the ability to interact with classmates and make new friends, and 14% found cooperative-learning projects to be more fun than lectures. Such social benefits indirectly affect students' academic performance as well.

Our results—together with those of others in the constantly growing literature on active learning—should be encouraging to both those considering the use of active-learning techniques for the first time and those already using them. The lecture, when combined with active-learning techniques, is a viable alternative to the traditional lecture-only format.

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