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ABSTRACT

Methods developed by faculty to involve students in the classroom are described in 13 articles, based on the experience of University of Minnesota faculty in the Northwest Area Program on Active Learning. Each article considers: how to get started, sample applications of the method, challenges and how to deal with them, rewards, and where to get help. Article titles and authors are as follows: "Using Primary Sources in the Classroom" (Elaine Tyler May); "Introducing Active Learning: Conceptual and Practical Problems" (William R. Charlesworth); "Cooperative Learning Groups" (Karl A. Smith); "Introducing Simulation and Role Play" (Terrie M. Shannon); "Structuring Controversy in the Classroom" (Deborah Deemer); "Using Active Learning in Large Classes" (Thomas F. Brothen); "Training Teaching Assistants to Use Active Learning Strategies" (Donald Ross); "Teaching Problem-Solving Skills" (Bert E. Fristedt); "Organizing Community Studies" (Peggy Sand); "Teaching Cognitive Skills to Underprepared Students" (Diane Chambers); "Personal Computers in Education" (Alan Wassyng, Karl Smith, Sam Sharp); "Questions and Answers about Active Learning" (Gloria Christopher); and "Northwest Area Program on Active Learning: History and Projects" (Russell Christensen). Four pages of references and a list of advisory committee members and staff for the program are included. (SW)

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Foreword

John R. Wallace

The Northwest Area Program on Active Learning has made a difference in the quality of undergraduate education at the University of Minnesota. It has shown us the excitement and intellectual energy that active learning modes bring out in students and faculty. It has projected the imagination and sense of collective accomplishment that conferences and workshops on topics in undergraduate education foster in faculty and administrators. Because the structure of the program required that departments make a collective commitment to projects submitted for funding, it involved groups of faculty, not only individuals, and created new opportunities for colleagues to exchange ideas. Perhaps most importantly, it has given new life and meaning to the term "active learning." John Dewey would be proud of us.

These are lasting changes that we are building on through the Educational Development Program, the Bush Sabbatical Program, and the Recruitment Project. I wish to thank Professor William Charlesworth, the chair of the Northwest Area Program on Active Learning committee, and Steven Schomberg, the director of the project, for their deft and creative leadership. I wish to thank the members of the committee and the staff of the project for their commitment and their thoughtful contributions. Especially, I want to thank the faculty members and students who actively taught and learned and so gave concrete proof of a dimension along which the University can improve its undergraduate program.

***John R. Wallace** is professor of philosophy and assistant vice president for Academic Affairs at the University of Minnesota.*

Introduction

Steven F. Schomberg

The idea for this handbook grew out of the work by University of Minnesota faculty in the Northwest Area Program on Active Learning. Faculty associated with this project developed and tested strategies to combat the passivity evident in our University classrooms. Over a three-year period (1982-1985), they tried out 20 methods of involving students in instructional activities, and trained more than 200 faculty to use one or more active learning strategies. This handbook presents some of the methods developed by faculty to involve students in the classroom. An annotated list of the other projects can be found in the final chapter on the history of the Northwest Area Program on Active Learning.

The strategies in this handbook describe how to structure a course so as to lead students out of a passive note-taking role into an active thinking role. I am reminded of a visit to a University of Minnesota classroom where I found the students working in groups of three, intensely engaged in a project. The faculty member interacted first with one group and then another: answering a question, volunteering a remark, sometimes just listening. When the bell rang, many of the groups continued working. This was quite a contrast to sleepy students, reading the *Minnesota Daily*, waiting to stampede for the door.

***Steven F. Schomberg** specializes in educational development and supervised the Northwest Area Program on Active Learning. An assistant dean of Continuing Education and Extension, he directs Summer Session at the University of Minnesota.*

Our concept of active learning involves students both in acquiring information and in interpreting or transforming it. Students work with the subject first-hand: exploring primary materials, organizing data, making observations, solving problems, or conducting experiments. Usually working within groups of peers, students are required to produce some type of product by interpreting information through analysis, synthesis, evaluation or some other form of reflection. The product may be a paper, report, debate, role play, problem solution, or model.

Faculty who conduct a course in an active mode usually have to make changes in their role. Whereas they previously may have focused their attention on organizing and interpreting information through lectures, they now concentrate on designing assignments, exercises, and tasks through which students will learn from first-hand experiences with the subject. Faculty act as mentors: guiding students through the subject matter, responding to student questions, encouraging student investigation. One faculty member reported on the invigorating effect of such a class: "The students and I both feel full of intellectual energy and ready for more as we near the end of the quarter; we hate to see it end."

The strategies described in this handbook complement lectures which also have an important place in an active learning environment. Subjects need to be introduced; illustrations and

instructions need to be given; unpublished information may be available only through a lecture. One type of lecture appropriate to active learning derives from classroom activities, student questions, and project results. By mixing lectures, student projects, recitation, and laboratory sessions, faculty enrich the learning experience.

In this handbook the articles are written from the point of view of practice. Each author briefly introduces the strategy and then addresses five aspects: how to get started, sample applications, challenges and how to deal with them, the rewards, and where to get help. Elaine Tyler May suggests how to use primary sources in undergraduate classes. Bill Charlesworth discusses the conceptual and practical problems of introducing active learning. Three faculty present general strategies: Karl Smith (cooperative learning groups), Terrie Shannon (simulation and role play), and Deborah Deemer (structuring controversy). Tom Brothen tells how he uses several active strategies in a large class with the aid of teaching assistants. Don Ross discusses the training of teaching assistants. Several faculty describe specific teaching strategies: Bert Fristedt (mathematical problem solving skills), Peggy Sand (organizing community studies), Diane Chambers (teaching cognitive skills to underprepared students), and Alan Wassyng, Karl Smith and Sam Sharp (personal computers in education). Finally, Gloria Christopher provides the evaluation information collected from faculty and students as answers to some often asked questions about active learning and teaching, and Russell Christensen presents the history of the program.

This handbook appears at a time when several national reports (e.g. *Involvement in Learning: Realizing the Potential of American Higher Education*, National Institute of Education, October, 1984) argue for classroom environments much like those discussed by the authors of these chapters. The recent reports by University of Minnesota faculty and students on the student experience and the quality of undergraduate learning signal renewed enthusiasm for improving teaching and learning. Both the national and local reports as well as the experimental work of the Northwest Area Program on Active Learning recognize that for classrooms to change, the faculty must adopt new teaching strategies. Resisting the inertia of the status-quo, they can work to constructively engage students In the 1960s we could count on the students themselves to challenge us toward more active teaching. In the 1980s, the faculty must challenge students toward more active learning. Using active teaching strategies such as those described in this handbook is one way of achieving this goal.

ACKNOWLEDGMENTS

Many people have collaborated on this handbook. Gloria Christopher and Russell Christensen helped design and edit it. Members of the advisory committee for the Northwest Area Program on Active Learning provided invaluable support. We are especially grateful to the Northwest Area Foundation and the Office of Educational Development Programs at the University of Minnesota for helping make possible the printing of this handbook.

Using Primary Sources in the Classroom

Elaine Tyler May

As teachers, we tend to present material to our classes in the form of the results of our discipline's work. We collect the data, do the reading, and synthesize the material into a finished product. Students, in their assignments and exams, are generally expected to demonstrate that they have learned what we as scholars have already found out. Rarely are they provided with the opportunity to make those discoveries themselves. And yet it is potentially very rewarding to offer students the opportunity to use raw materials themselves, giving them "hands on" experience *doing* the work of the discipline. For example, in my own field of history, it is one thing to tell students what we have discovered in the process of research. It is quite another to invite them to "do history" with us. I remember well my own first experience using primary documents for a research project. Pulling off the library shelves ancient documents from another era was like entering a time machine. Attempting to make sense of those rich materials was a far different experience than listening to a historian lecture about somebody else's findings. Few students actually delve into primary source materials until quite late in their college years, if at all. Much can be gained, however, by using primary sources in the classroom, even in introductory courses.

***Elaine Tyler May** is an associate professor in the Program in American Studies at the University of Minnesota.*

Primary sources are the materials scholars use to construct their research projects. For classroom use, a primary source can be anything that has not been interpreted for the student already. The types of primary sources available vary greatly, of course, depending on the discipline. Census data, voting records, public opinion polls, survey questionnaires, or court case records are examples of primary sources used by social scientists; novels, poems, paintings or photographs, songs or musical compositions, letters, diaries, or even family artifacts can be used by teachers in the humanities. Students in the sciences or medicine can work with raw substances or case records. Primary sources can be found in books, archives, or in the world around us. Students can, with appropriate guidance from the instructor, learn to find, study and interpret primary source materials for themselves. The possibilities for classroom use are truly limitless.

How to Get Started

In order to get started, instructors must think through the class project or assignment very thoroughly. It is easy to forget basic steps because we tend to take certain parts of the process for granted. For example, I made a serious error when I assigned students in an introductory class a very basic and simple research task, but failed to explain to them how to use the library. Many of the students did not even know where the library was located, much less how to find anything in it. A brief

orientation would readily solve that problem. It is essential, therefore, to anticipate the needs of the students. Never assume that they have prior experience that would equip them for the task at hand.

1. *Choose the sources students will be using.* Decide whether you should provide the students with the raw materials, or whether it is practical for them to find their own sources. If they will be searching for sources themselves, be sure to provide detailed instructions on how to locate and choose appropriate materials.

2. *Plan the assignment with a view to the overall results.* Begin by thinking of the total project, not simply the kind of material you wish to use. Think about the process. What question or sorts of questions do you want the students to pursue? What kinds of materials and methods should be used to accomplish the task? Keep the task very simple, yet allow for the greatest possible discovery on the part of the students.

   The types of assignments can vary a great deal, from in-class group projects to short individual assignments to term papers. Once you have determined the nature of the task, it is useful to break it down into components. How should the students work with the materials? Spend some class time discussing the concerns of the discipline and what scholars in the field do when they pursue their research. Give the students ideas of the kinds of things they should look for in the materials they use. It is often helpful to discuss your own work in this context. Professor Mary Dietz, in the Political Science Department, was quoted in a recent issue of *Update* saying that she incorporates descriptions of the process of her own work — not just the results — into her class lectures. This can be a helpful and illuminating way to involve the students in the task at hand while at the same time sharing your own trials and tribulations as well as your discoveries. Students will be less likely to feel discouraged if they realize that this type of work does not come easily even for scholars in the field.

   Along with specifics as to length, format, etc., it is important to provide the students with a strong sense of what they can discover for themselves. Unlike many exams or homework assignments, working with primary sources usually provides more possibilities for interpretation and creativity. Encourage students to explore, use their imaginations, and develop some of their own questions. At the same time, they should be given clear guidelines so they do not flounder while trying to figure out what is expected of them.

3. *Allow students to share results.* Results can be submitted in either written or oral form. It is rewarding for the students to present their results to the class. This can be done as a mock professional meeting, with mini-papers and workshops, or as oral reports, or in small groups working informally with each other. It is well worth at least one class session, or more, for the students to share the process as well as the results of their work.

"...it is one thing to tell students what we have discovered in the process of research. It is quite another to invite them to 'do history' with us."

Sample Applications

In American Studies, my colleague Lary May and I developed a classroom exercise that would help students identify with Americans who lived at a different time and in a different social and cultural context. We wanted students in the introductory course to have the chance to roll up their sleeves and dig into primary sources for themselves. We also wanted to expose them to the process of "doing history."

To achieve this, we experimented with several different types of assignments. One involved having students explore a particular topic by choosing a journal for examination at two points in time fifty years apart. Each student was required to examine how a particular social issue under consideration was discussed or portrayed in each instance and to describe how views on the issue had changed in the same publication over five decades. The assignments yielded some exciting results and exposed some of the students to an entirely new way of perceiving the past and the process of historical change.

One particular example stands out in my mind. A student chose the *Minnesota Daily* as her periodical and the issue of women's work and politics as her focus. She went to the archives and selected issues from the years 1918 and 1968. As she wrote in her paper, she selected those years intentionally, expecting to find few references to women, their work opportunities, or their political organization in the dusty issues from 1918, and evidence of substantial gains for women by 1968. To her astonishment, the progress she expected to find was not there. In 1918, the *Daily* was filled with announcements about job opportunities for women, political organizations for women students, suffrage clubs, meetings, articles and editorials written by women, and a flurry of evidence indicative of a rich and lively feminist community on campus. By 1968, that activity seemed to have vanished. There were plenty of articles focused on campus politics, the anti-war movement, and editorials about the New Left. But women were virtually absent from the pages, except in the job listings for secretaries and babysitters. The discovery dramatically altered her vision of progress in women's emancipation and the politics of the 1960s before the rebirth of feminism. The discovery was vivid and exciting because the student made it in the course of her own research in primary source materials, in this case our own campus newspaper.

In another class we set up a series of role-playing panels in which each student on the panel came to class as a particular historical figure and participated in a discussion focused around a concern that would have occupied the thoughts and energies of his or her character. To do the research for the panel, students were required to investigate available primary sources concerning the individual each was to portray, as well as the issue under discussion. If the subject was slavery, for example, one student might read the diary of a plantation mistress, another a memoir of an escaped slave, another the writings of a northern abolitionist, and so on. Students thus had the opportunity to dig

into the material themselves, and then to attempt to get inside the mind of a particular historical character. The panel was set up in a "Meet the Press" forum, with the rest of the class acting as the press corps. (Over the course of the quarter, everyone in the class served as a panelist.)

The panels worked very well, sometimes even too well. Along with spontaneous and sometimes carefully researched costumes and deep involvement in the characters portrayed, we also had some dramatic events we did not anticipate. There was, for example, the day when "Meet the Press" focused on the question, "Can native American Indians and white settlers coexist on the frontier?" The class shifted into the nineteenth century and near the end of the panel discussion, Chief Crazy Horse assassinated General Custer right in front of the class. Or there was the day we moved into the ante-bellum South to discuss slavery, and a young slave girl (played by a rather large male student) crawled out of the room on hands and knees to escape her cruel and lustful master. Despite these dramatic excesses, or perhaps because of them, the students did manage to do a very serious job of researching their characters. During the "Meet the Press" sessions, the "press corps" asked questions that would yield the most useful information since they knew that the class was responsible for the panel material in papers and exams. In this way, the instructors provided the guidance and back-up, but it was the students who were literally responsible for developing class materials and learning from each other.

Another strategy that proved effective was to have students in a large class work together in small groups. These groups provided more than a forum for discussion, although this was one important function. In addition, they provided the arena in which primary sources were presented and analyzed. Small groups are often difficult to arrange because of the problem of staffing and limited resources. We experimented by involving a group of upper-division students who are majors in the program, offering directed studies credit for their work as undergraduate teaching assistants in the course. Groups were established during the first week of class, and the same students remained together for the entire quarter. This enabled students to get to know one another and participate in an informal, small-scale learning environment far removed from the typically large and anonymous lecture class. The undergraduate teaching assistants met regularly with the instructor in an ongoing seminar throughout the quarter which provided continuity and a structured way to provide input into the groups. The student teaching assistants served as facilitators rather than teachers, and the members of each group were responsible for contributing to the learning that took place.

One group activity that worked quite well was an assignment for each student to take her or his date of birth and go back thirty years. They were then to choose a periodical published at the time and find the major issues discussed in that journal during their birthday week that year. When they came together in the group, the task was to construct, drawing on everyone's findings, a cultural portrait of the area. Since not everyone in the class was the same age, they were able to discern patterns of change over time. Individually, students were required to delve into primary source material. Collectively, in the small groups, they were to pool their findings in order to draw some conclusions about cultural history and the process of change.

"Once you begin discussing teaching ideas with colleagues, you may find that others have been using primary sources in the classroom in numerous innovative ways."

One final item provided an interesting dimension to the class. I attended a workshop on "student-generated data bases" as part of the Northwest Area Program on Active Learning and was intrigued by the thought of adapting an in-class survey to an American Studies course. We decided to take a class census which included questions that would be relevant to the themes of the course. We then tallied the responses and copied the results for the students in the class. Throughout the course, we continued to refer to the "collective biography" of our class to indicate the pervasiveness of the course themes and their immediacy to the students' own experiences. By asking students to provide their "ethnicity," for example, we could discuss the various ways in which people define their cultural heritage.

Once you begin discussing teaching ideas with colleagues, you may find that others have been using primary sources in the classroom in numerous innovative ways. For example, in a recent workshop on using primary sources in the classroom, I learned about an interesting project regularly assigned by Riv-Ellen Prell in the Anthropology Department. Professor Prell endeavors to give the students a sense of the power of cultural norms by asking them to discover commonly-shared assumptions in our own society. One of the first assignments is for students to break an American cultural rule in public and write up the experience. In this way the student's own world becomes the primary source laboratory. Students learn the force of unwritten social customs by attempting to enter a grocery store and barter for goods, for example, or by sitting next to the sole passenger in an empty bus.

Mary May, in American Studies, has used the public arena as a primary source by having students go out and observe a building, a park, or a social institution such as a movie theater. The students are instructed to describe what they observe and analyze the place or institution in terms of its origin, history, use, structure, and what it can tell us about the culture.

Other instructors draw upon the rich sources available in the many archives of the University. Researchers frequently use such collections as the Social Welfare History Archives, the Immigration History Archives, the rare books and manuscripts, children's literature, or government documents. These materials can often be used for class assignments. Recently, for example, David Klaasen, curator of the Social Welfare History Archives, assisted Professor Sara Evans of the History Department in setting up a set of research packets for students to use. Choosing from among the packets, each student investigates a particular issue in twentieth-century women's history. The packets made the relevant material readily accessible to the students, who then explored the documents and wrote up their discoveries.

These are only a few of the endless possibilities that might be tried in or adapted for classroom use.

Challenges and How to Deal With Them

As with any other teaching device, primary source projects can present difficulties. The most common, perhaps, is the students' unfamiliarity with this type of assignment. There is need for extra guidance and assistance from the instructor. Be sure to set aside plenty of class time for explanation, questions, and discussion. Hold adequate office hours so students who encounter difficulties can come to you for assistance. You may find that some of the materials you think would be most appropriate for students may in fact baffle them. Some trial and error will undoubtedly be necessary in choosing sources and structuring assignments. When possible, allow the students as much individual choice as possible. The assignments will be more meaningful if the students have maximum input. The more reluctant and inexperienced students will undoubtedly need the most help, and instructors will need to be prepared to offer help when needed. For longer assignments, it is often helpful to require a brief "progress report" or, if the class is not too large, a conference with the instructor. In large classes, it may be useful to have students meet in groups before the assignments are completed, to discuss difficulties with each other and share ideas. The students will learn the most when they have adequate guidance and feedback along the way.

In general, it is best to avoid abstract notions and to make the assignments as well as the sources as tangible and specific as possible.

The Rewards

Even if difficulties arise along the way, the experience is likely to be rewarding for students and faculty alike. As an instructor, you are in essence establishing an apprentice relationship with your students. Your example and guidance gives them an opportunity to do some of the work of your discipline even if it is on a small scale. You may even be surprised, on occasion, to find that a student has discovered something that does amount to a new contribution to the field.

"As an instructor, you are in essence establishing an apprentice relationship with your students."

In addition, we have the satisfaction of knowing that students in our class acquire an actual learning experience rather than simply a collection of facts and information. Studies of the process of learning -- how individuals acquire knowledge, skills, and problem-solving capabilities — have provided some disquieting evidence. One statistic that sticks in my mind (no matter how hard I try to shake it) is that students who learn in the "traditional" college classroom setting — listening to a lecture, taking notes, and demonstrating their acquired knowledge in exams — retain, six months later, the paltry proportion of twenty percent of what they "learned." That means that within half a year, eighty percent of our pearls of wisdom have evaporated into thin air. When we provide the students with the opportunity to make their own discoveries, they retain not only the knowledge they acquired but the skills of doing scholarly work on their own.

Where to Get Help

The Northwest Area Program on Active Learning workshops provided plenty of ideas that we were able to adapt to fit our classroom needs. One thing the experience proved is that as teachers we have a lot in common and can share ideas with each other, even if our scholarly pursuits are quite diverse. Our best resources, then, are our colleagues, in our own or in different disciplines. Some of our best ideas for teaching American Studies come from strategies developed by individuals in such unlikely fields as agronomy and psychology. What is most important, I think, is that we get together and share ideas as teachers. We take for granted the numerous seminars, colloquia, and conferences devoted to research efforts. We need to recognize the value of forums for our work as teachers, too.

In addition to sharing ideas with one another, it is important to know that places on campus can provide a great deal of help and guidance. The Office of Educational Development Programs can be of tremendous assistance, especially in alerting individuals in one area about what people in other parts of the university are doing. In addition, the curators and archivists in the many special collections in the University can be very helpful in putting together materials for classroom use. The curator of the Social Welfare History Archives, has expressed willingness to bring groups of students into the archives, organize materials for them, and visit classes to provide orientation. Other members of the archives' professional staffs would no doubt be willing to do the same.

Lastly, we should all make an effort to put teaching strategies on the agenda of our departmental meetings. We might be surprised to find out what interesting things are going on in the classroom right next door.

Introducing Active Learning: Conceptual and Practical Problems

William R. Charlesworth

Introducing active learning into a large lecture class requires at least two kinds of changes —conceptual and practical. Both have to be dealt with before the class syllabus is written; one could argue that both have to be dealt with even before the course is listed as an official offering. The original function of the course and how this function fits with those of other courses in the department may well have to be changed if active learning is adopted.

Active learning can require, in unexpected ways, a reconceptualization of course material as well as pose interesting practical problems. An example is setting up class conditions to replace lectures. Such a task can be initially frustrating, especially for instructors who rely solely on texts and lectures to carry the main weight of information transmission. Fortunately, tips toward solving these problems can be passed on quite quickly in the form of explicit procedures. Some of these procedures will be presented below. Let us begin with some major conceptual issues.

How to Get Started

Developing a course that gives students full reign to seek out information actively and solve problems on their own can be conceptually very different from one in which the information is authoritatively delivered in the course text and lectures.

***William R. Charlesworth** is a professor in the Institute of Child Development at the University of Minnesota.*

Thus the shift to active learning has to be well thought out. For example, the instructor has to begin by asking what knowledge of the discipline is worth having, and hence worth the students' hard work to get and retain. It requires a long process of winnowing down vast amounts of information and making tough value judgments along the way.

The instructor who wants to focus on a limited set of vital bits of knowledge to get across to students has to make such judgments. These vital bits of knowledge may comprise many things depending upon the discipline — overriding principles, major empirical events, intractable methodological problems, taxonomic dimensions — whatever holds the discipline together conceptually. And because of the magnitude of these bits, one cannot include many of them in a ten-week course. My experience has been that eight to ten of them are plenty. This may be due partly to the fact that I usually use group problem solving as an active learning strategy to get them across. In such courses active learning takes up approximately 60% of class meeting time; the rest consists of lecturing and answering questions.

Examples of "vital" bits of knowledge I had to pose in the forms of problems for three different child development classes are: (1) in an introductory course, students examine how to study and evaluate the effects of intervention on child behavior and development, a seemingly dry exercise until they see the methodological problem

"What is often forgotten is that 'problem' is a relational term — a characterization of a different relationship between an arresting stimulus and the forward movement of the student's mind."

embedded in public claims, government programs, ideological attempts to influence education, popular accounts of day care, child rearing etc.; (2) in a course on deviant behavior, students have to deal with the problems of classifying persons and behavior (the functions of classification); the pros and cons of diagnosis and prognosis as they are applied to real life case studies; (3) in a course on the ethology of human behavior, students are asked to defend the use of functional categories [illegible]havior, viewing functions in terms o[illegible]ctive factors and long term consequences. In all cases the solutions to the many facets of the problems are not immediately available in any particular source.

In working on such problems, textbooks, readings, and lectures are used. They serve as familiarizing material, as sources and stimulators, while they support the instructor. Usually, texts lay out a field topically along a dimension or two — time, size, complexity. The vast majority of them are not problem-oriented, although they often have problems at the end of chapters. These students do not work on the problems because they are usually not central to course requirements. But this may all be to the good. Students read the text, listen to lectures that clarify points in the text, get engaged in classroom discussion and work on problems, and the instructor writes the problems. Actually, the instructor is better qualified than anyone to do so because it is the instructor who knows the students' minds, attitudes, propensities, etc.

What is often forgotten is that 'problem' is a relational term — a characterization of a difficult relationship between an arresting stimulus and the forward movement of the student's mind. One must know both the nature of the stimulus and the nature of the student's mind to make pedagogical progress. Instructors who do not know the information level of their students can really not create educationally meaningful and challenging tasks for them.

Challenges and How to Deal With Them

A major issue is how to get a task formulated that has a clearly stated objective and alludes (either directly or indirectly) to the specific problems that stand in the way of attaining this objective. Most tasks are couched in terms of either interrogatives or imperatives. Examples: What is a good example of X? Describe its compositon. How did X become that way? Explain what changes took place that made X possible. What would have happened if. . .? Prove your point. Distinguish between X and Y. Interpret the following passage in terms of.

Imperatives and interrogatives usually serve familiar functions and can be stripped down to cognitive actions such as *describe* the nature or development of X, *explain* how X became this way, *compare* X with, *predict* what would happen to X if, *prove* by logic or data that, *evaluate* X in terms of. These actions specify what has to be done to solve the problem; they also clearly state what form the solution will take: a description, explanation, comparison, prediction, proof, evaluation.

If one knows one's discipline well, writing such problems is challenging and also fun. If one is just getting to know one's discipline, it can be agony. The solutions to problems are available either in one's mind or in texts, writings, etc. In these cases, setting the criteria for evaluating a solution is relatively easy and should be done in writing immediately after the problem is formulated. One should not take anything for granted — even one's conception of a problem. Occasionally I write solutions first, then the problems, just to be sure that the isomorphism between what I think of as a problem and what I think is a solution really exists. If one is just getting to know one's discipline, formulating problems can be very difficult. At times like this, colleagues are very valuable.

Problems that allow immediate criteria setting are often referred to as convergent problems. Their answers converge on conventionally or logically established standards. Solutions to these problems are relatively easy to evaluate. Divergent problems, however, are another matter: they open up to the unknown and usually involve such verbs as *invent, plan, generate, create, come up with,* etc. Such problems require brainstorming and probably should be introduced near the end of the course. Then the student is better prepared and can recognize constraints even the greatest creation must have in order to be reasonable, useful, and interesting.

Objectively evaluating such solutions is obviously difficult. Ludicrous solutions get the low grade they deserve; the other solutions may have to be compared with each other and then graded. I posed such a problem only once in a class dealing with atypical children. It required inventing a toy or game for deaf/blind children at two different ages — infancy and early childhood. I could categorize four classes of solution — trivial or uninteresting (not novel), so-so, average, and very good and imaginative. Specific criteria I used were appropriateness to deaf/blind behavior, appropriateness to developmental level, and imaginativeness. Obviously other criteria could be used and to this day I am sure justice was not equally distributed across all solutions. But that's the price of having fun in active learning.

The main point of all this is that once one decides to shift part of one's course to an active learning mode such as group problem solving, interesting conceptual issues arise in reference to the nature of the knowledge in one's discipline and how the knowledge is structured and presented to students. The choice of texts and readings and the nature of lectures are significantly affected by these issues. The practical changes that one has to face when such a shift is undertaken can be numerous

and lead to all kinds of trial and error activities. At this point acquainting oneself with some procedures may be helpful. Here is a partial list.

1. *The percentage of classtime devoted to active learning is decided by at least two major factors* — how confident the instructor feels in relinquishing lectures and turning over transmission of the course material to readings and student activity, and how much experience entering students have with group problem solving or other forms of active learning. My experience with our introductory course in child development reveals that approximately one class period a week of group work per se was ample and desired by a great majority of the students. The minority was divided into those who wanted fewer lectures and those who wanted all class time to be devoted to lectures. More advanced undergraduate courses, in my estimation, should increase active learning up to or over 50% and graduate courses could consist of 90% of active learning. In all cases the instructor (when not lecturing) sets problems, guides problem solving, serves as a resource and evaluates the active learning products of the students.

2. *Try to ensure that the classroom is large enough to allow groups of four (four is a well-tried and successful number) students to spread themselves comfortably about the room.* A classroom with twice as many seats as students works well. Classrooms with movable chairs make life easier, but I have found that large amphitheaters with fixed seats pose no great problem. Frequently, three students sit in a row and the fourth faces them, sitting on the arms of the seat in front of them.

3. *Assigning students to groups is best done randomly or as close to it as possible.* This leads to a sense of fairness, breaks up tight affiliations, and ensures that not all the front row students end up together. Mixing front rowers with rear rowers may produce some interesting reactions. Part of the group experience is to learn how to deal with unfamiliar peers in a situation requiring collective action. While such learning is not the primary aim of the class (learning the substantive matter, in my view, is), it is important not only from a social point of view but also from a cognitive point of view. For example, students are required to take on the perspective of others when formulating their knowledge or posing their questions for the group's benefit. A simple way to assign students to groups is to use class lists and a table of random numbers, especially if the students are already listed in numerical sequence.

4. *Before the tasks can be tackled, students should be aware of at least three things that could become problems:* (a) *personal* — each student has to adjust to working in the group, overcome inhibitions to talk, share ideas with others, control excessive monologues etc., (b) *group* — each group has to divide up the task and assign each group member to deal with a certain part, coordinate the group's activities, deal with delinquencies, etc., (c) *resources* — the group must identify readings, materials, etc. necessary to solve the problem as well as arrange for times and places to meet. Students should be made aware that these are three normal parts of the process of group problem solving and cannot be ignored.

5. *Providing the groups with problem tasks has to be done systematically and with ample time for all parts of the process.* The tasks must have a connection with the lectures and readings, both past and future; that is, they should link with ground already covered as well as extend into new areas. This means they have to have a solid conceptual connection with the rest of the course. The task is given a title, written up (usually a half sheet typed will do), and handed out to each student before class on Wednesday. Students are instructed to read it and make preparations to solve it (by doing the appropriate reading, thinking about it, discussing it with friends, etc.) by Friday, the following class period. The group then meets at the end of the class (Wednesday) and assigns specific jobs to solve the task. Five minutes will suffice.

6. *The following meeting (Friday) is dedicated to group activity.* Each group is given a blank product sheet which will represent their solution of the problem. This sheet lists the problem title, gives the date, designates space for the group's solution and space at the end with four spaces for each group member's signature (as evidence that he and she contributed to solving the task). Space for the grade given the solution is left in the upper right hand corner. Both sides of the paper can be used for the solution. An extra sheet can be added, but solutions should be kept short. Grading time is a factor, especially in large classes.

7. *After receiving the solutions, the instructor and teaching assistants discuss what constitutes an adequate answer.* This is done after reading through a number of the exams and in light of pre-established criteria. Suitable solutions are agreed upon and the solutions are read, graded over the weekend, and handed back the following Monday in class. In class I usually read aloud two high scoring solutions and two low scoring solutions, giving reasons for why they were evaluated as such. The two groups scoring high are mentioned by number and asked to take a bow. Usually they will not. Sometimes one can go too far with rituals. The two groups scoring low are not mentioned by number but stared at vigorously.

"... once one decides to shift part of one's course to an active learning mode such as group problem solving, interesting conceptual issues arise in reference to the nature of the knowledge in one's discipline and how the knowledge is structured and presented to students."

8. *Each group member whose signature is on the solution sheet receives the group grade.* Adjustments are made; bonus points can be given, for example, for a group member who contributes disproportionately more than others to the solution. Group members have to agree on this. They also may agree that some member contributed disproportionately little to the solution. Group dynamics and control of individual behavior is often an important issue for some groups and may in some cases lead to dissension, revolts, uprisings. Such groups are counseled to stay together, be as explicit as possible in dividing up the task amongst all four members, hold each other and themselves accountable, and be prepared to make their individual contributions when the solution is being written up. Occasionally, such fine advice does not work and the outlaw is either transferred to another group or given the same tasks (as the rest of the class) to work on individually. What percentage of the individual student's final grade is based on the group's performance has to be decided in light of many factors. How confident the instructor feels that the tasks represent the vital knowledge of the course, how much working on the task solution actually contributes to acquiring general knowledge of course material which will be measured in the final exam or term papers, how much out-of-class time is required to work on the solution.

9. *Some groups in my classes met over weekends and worked together for several hours; other groups met seldom, some not at all.* If after a few tasks individuals see the connection between their work on them and the material covered in lectures and brought up in quizzes or the midquarter exam, effort becomes more meaningful (for the practical minded at least). If I think the tasks are getting at essentials, I give their solutions more weight in the final grades — so far I have ranged from 10-40% of the final grade. When I feel more confident in the future about the tasks, I may increase the weight.

The Rewards

Active learning in large lecture classes can become a reality if one is willing to make changes, some of which may be greater than originally anticipated. In my own experience I began the change by simply concluding that students were being lectured too much and instead should be actively engaged in

problems. But when it came to creating problems, the question arose: is this piece of information really worth working for, worth mulling over, arguing about, and putting into writing? Interestingly enough, this question never occurred to me over the years when I was writing hundreds of multiple choice items, fill-ins, and short essays. My feeling, I guess, was that if one writes enough questions it was worthy of me to ask them and definitely worth it to students to know them. I must have thought that collectively they were a good thing, while recognizing that individually not one was worth remembering. But such irrationality cannot last forever. Time is short. Students have other things to do and remember. So instructors have to choose the best the course has to offer and hit students hard with it with the right classroom procedures. Active learning using group problem solving is a good way to do it.

The rewards of teaching a single course are usually elusive -- for instructor as well as student. They are difficult to measure, often submerged in the wave of new courses or summer vacation. But surely educational rewards exist and endure in one form or another. Culture would not be possible if they did not. The form of rewards may be emotional — feelings of strong satisfaction that come with accomplishment. The act of solving problems has a peculiarly strong positive effect on human beings. Both student and instructor experience this effect, the former in working towards a solution, the latter in constructing the problem. And the solution itself adds emotional reward, especially if it is a solution that meets high standards and hence high recognition.

Rewards of teaching may also take another form — cognitive or epistemological. Acquiring new and valid knowledge is by definition what we mean by mental progress and this progress both improves adaptation and enriches life. Humans cannot improve adaptation or enrich life in any other way: we have to be educated to do so. Learning to grapple with problems important to a domain of knowledge is one way to acquire new and valid knowledge. Putting effort into such an activity, whether as an instructor or student, is what active learning is about and learning something is always a reward.

Cooperative Learning Groups

Karl A. Smith

In a cooperatively structured lesson, students are placed in small groups and given group assignments to complete while the instructor insures that members of each group actively discuss the lesson, master the assigned material, and receive rewards on the basis of how the group product compares with preset criteria of excellence. Cooperative instruction thus creates a situation in which students are responsible not only for their own learning but also for the learning of the other members of their group.

Cooperative learning involves much more than simply having students share or discuss material with other students, although this communication is obviously important. The real crux of cooperative learning is that the group shares a goal, such as producing a final report or achieving a high group average on a test. The effectiveness of a group carrying out its goal is determined by the presence or absence of four essential elements of cooperative group learning (Johnson, Johnson, Holubec and Roy, 1984).

First, cooperative learning requires that group members develop positive interdependence. In order for their learning situation to be cooperative, whatever the task, students must perceive that they are positively interdependent with other members of their learning group.

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Second, cooperative learning requires face-to-face interaction among students. There is no magic in positive interdependence in and of itself. It is the interaction patterns and verbal interchange among students promoted by the positive interdependence which affect educational outcomes.

Third, cooperative learning requires individual accountability for mastering the assigned material. The purpose of a learning situation is to maximize the achievement of each individual student. Determining the level of mastery of each student is necessary so students can provide appropriate support and assistance to one another.

Finally, cooperative learning requires that students use interpersonal and small-group skills appropriately. Obviously, placing socially unskilled students in a learning group and telling them to cooperate will not produce the desired results. Students must be taught the social skills needed for collaboration and be motivated to use them. Students must also be given guidance in analyzing how well their learning groups are functioning and to what extent the group has been successful in achieving and maintaining effective working relationships.

How to Get Started

The procedure for implementing cooperative learning developed by David and Roger Johnson is a general procedure, specific enough to provide guidance, but flexible enough to be adapted to each instructor's specific teaching situation. The Johnsons outline five major tasks which the instructor should address in organizing group learning activities.

1. *Clearly specify the objectives for the lesson.* Two types of objectives must be specified before the lesson begins — academic objectives and collaborative skills objectives.

2. *Make decisions about placing students in learning groups before the lesson is taught.* Select the group size most appropriate for the lesson. Cooperative learning groups tend to range in size from two to six. The optimum size of a cooperative group will vary according to the resources needed to complete the lesson or project (the larger the group, the greater the resources available to it), the cooperative skills of group members (the less skillful the group members, the smaller the group should be), the nature of the task, the materials available, and the time available.

   Usually, when assigning students to groups, you will want to maximize the heterogeneity in the groups. Random assignment normally insures a good mixture of males and females, highly verbal and passive students, leaders and followers, and enthusiastic and reluctant learners. Sometimes you may want to let students choose whom they work with; sometimes you may want to group students according to their interests. Nonetheless, random assignment is the most highly recommended procedure.

   Arrange the room to facilitate group activity. Cluster the groups of students so that they will not interfere with one another. Within the groups, all students should be able to see the relevant material, talk with one another, and exchange ideas and materials. Usually a circle is best, and long tables should be avoided.

   Plan instructional materials to promote interdependence among group members. Lesson materials can be structured to promote effective academic learning and positive interdependence among group members. When students are first learning to cooperate, or when some students are having problems contributing to the group work, you may want to arrange the materials like a jigsaw puzzle and give each group member one piece to force students to begin the process of cooperation. One group, for example, could be writing a report on alternative energy resources, each member being responsible for material on one different type. For the report to be completed, all group members have to contribute material and work together to incorporate their individual contributions into the report.

"Students must be taught the social skills needed for collaboration and be motivated to use them."

Assign group members roles to insure interdependence. Interdependence may be arranged through the assignment of complementary and interconnected roles to group members. This is useful for inexperienced group members. For example, the group should have a summarizer-checker, researcher-information gatherer, recorder, encourager, and observer. Some assistance may be needed from the instructor to insure that such complementary roles are developed quickly by the groups.

5. *Carefully explain the task, goal structure, and learning activity.* Several aspects of explaining an academic assignment to students should be considered, such as: setting the task so the students understand the assignment, explaining the objectives and relating the concepts to the students' past experience, defining relevant concepts, and asking questions to check the students' understanding.

   In order to structure positive goal interdependence, you must communicate to students that they have a group goal and must work collaboratively. This may be achieved by developing mutual goals (goal interdependence); establishing divisions of labor (task interdependence); dividing materials, resources, or information among group members (resource interdependence); assigning students differing roles (role interdependence); or by giving joint rewards (reward interdependence).

   Provide means for insuring individual accountability. To insure that all members learn, you must assess the performance of each group member frequently. This can be done, for example, by giving practice tests or by randomly selecting members to explain group answers.

   Explain criteria for success, as competition for grades may "break down" student cooperation. Evaluation within cooperatively structured lessons needs to be based on criteria established for acceptable work rather than on a grade curve. The criteria by which students' work will be evaluated should be clearly explained at the beginning of each lesson so that students and groups are aware of the instructor's expectations from the outset.

   In specifying group tasks, the instructor should be careful to explain the behaviors necessary for successful task completion. For instance, using phrases such as "make sure everyone participates," "listen carefully to other group members," and "have each member explain how to get the answer" in your task instructions will get better results than simply telling groups to "discuss today's topic."

4. *Monitor the effectiveness of the cooperative learning groups and intervene to provide task assistance (such as answering questions and teaching task skills) or to increase students' interpersonal and group skills.* Observe interactions between students. Asking students to cooperate does not necessarily mean they will do so. Much of your time should be spent observing the groups to see if their problems are functioning effectively.

   In monitoring the groups as they work, you can help the students if you clarify instructions as needed, review important procedures and strategies for completing the assignment, answer questions, and teach task skills as necessary.

   Provide closure to the lesson. At the end of the lesson, students should be able to summarize what they have learned, understanding how they will use the information in future lessons. Teachers may wish to summarize the major points of the lesson, ask students to recall ideas or give answers, and respond to any final questions they might have.

5. *Evaluate student achievement and help students discuss how well they collaborated with one another.* Evaluate the quality and quantity of students' learning. Evaluate the group product (report or single set of answers agreed upon by all group members, for example) according to criteria clearly established prior to the assignment. Assess how well the group functioned. Assessment should focus both on members' contributions to one another's learning and on the group's success in maintaining good working relationships.

In our cooperative learning workshops with educators we have stressed the importance of curriculum building and teamwork. In fact, we have found that it is much easier starting cooperative learning if you have a cooperative group of colleagues. It is also helpful to start small and build. Cooperative learning groups should evolve into a teacher's program. You might try using learning groups for a few activities at first. Ultimately, you may find that the majority of class work, if not all of it, can be carried out most successfully in a learning group environment.

Sample Applications

Cooperative learning procedures have been implemented in several courses in Civil and Mineral Engineering. Typically, students are given a problem to formulate and solve. Initially, they are told little about the nature of the problem, since the emphasis is on developing their skill to formulate problems. Students then work in small groups to formulate and solve the problem or frame the concept and prepare a report on how the problem was solved, either on an overhead transparency or on paper. Later, a representative from each group is then often selected (randomly) to present the group's solution. Finally, the approaches and techniques used by the various groups to solve the problem are compared in class

The next two sections describe the application of cooperative learning in two specific courses: Systems Analysis and Environmental Issues.

"The use of the cooperative goal structure approximates more closely the activity of real-world employment and problem solving . . ."

Systems Analysis

The major objective of the Systems Analysis course is to help students learn to formulate and solve practical problems with the assistance of five operations research techniques — decision theory, linear programming, network analysis, expert systems and simulation. The instructional methods used in this course are described in Smith, Warsyng and Starfield (1983); Smith, Starfield and Macneal (1985); and Starfield, Butala, England and Smith (1983).

The "bus problem" is an example of one of the many informal problems given in the systems course. It is a problem requiring a decision and a recommendation on whether to purchase 25 or 50 buses. The problem can be formulated very well by decision-tree methods, but since most students have never heard of these methods they use a wide variety of approaches which all contribute to a very interesting discussion. The description of the task is to "Determine how many buses to buy and give a rationale for your answer." The expectations listed are: "Work cooperatively, one answer from each group -- place on transparency; every group member must indicate that she or he understands the group's solution and can explain it; make sure all group members have their say, and assist all group members in understanding the material." One person is selected randomly from each group to present the group's solution, using an overhead projector. It is emphasized that groups are not competing and that this exercise will not be formally evaluated.

Generally two approaches to the solution emerge, one that emphasizes minimizing the maximum possible loss and one on maximizing expected gain. Subgroups within each group are then assigned the task of preparing each of these approaches for presentation of a rationale during the next class period. A structured controversy discussion is then conducted during the next class period.

Following this, the sequence of instruction varies but includes most of the following steps. A structured tutorial is often used to draw out the important elements of the students' formulations and solutions. Comparisons are made among the various approaches. Occasionally a lecture is given to highlight the main points of the formulation and solution and to introduce or clarify important algorithms or heuristics.

A moderately difficult problem is then assigned for each group to solve by hand calculation. A computer package is introduced that more quickly performs the calculations they've been doing by hand. The personal computer permits the students to revise their formulation and repeatedly solve the problem. Thus they can ask "what

if questions and check the sensitivity of their solution to the problem formulation and assumptions. Finally, a complex, slightly open-ended problem is assigned. Open-ended problems are ones that are not completely described. Students are not informed as to which aspects of the system should be included for analysis since, typically, they get no such direction in the "real" world. The student groups formulate and solve this problem using the computer package. Discussion and interaction are required since the solution is sensitive to the formulation and assumptions.

Each group presents its findings in both an oral and a written report.

Environmental Issues

Our environmental issues seminar, conducted annually in the College of Liberal Arts Honors Program, focuses student attention on such issues as energy production, hazardous waste, air pollution, acid rain, and wilderness areas. Cooperative group learning with structured controversy is featured as the format. Controversy exists when one person's ideas, information, conclusions, theories, or opinions are incompatible with those of another person, and the two seek to reach an agreement (Johnson and Johnson, 1982). Since controversy is an inevitable part of any group's natural interaction, it follows that if it is managed effectively, controversy can lead to an exciting and effective group learning experience. The course focuses on content acquisition *and* on helping students develop collaborative skills (through small group work), constructive conflict management skills (through structured controversy discussions), and perspective-taking skills (through presentation and discussion of different perspectives on each issue). This procedure is described more fully in Johnson, Johnson and Smith (in press), Peterson (1983), and Smith (1984).

Challenges and How to Deal With Them

Restructuring courses from a lecture format to a student-centered, small group format in which students become actively engaged is both rewarding and frustrating. The switch from lecture to learning groups requires that the instructor prepare plans for student activities rather than lecture notes. It also involves providing students with access to materials, including handouts with descriptive material, concepts, examples, study questions and homework problems.

Abandoning the notion that lecturing and teaching are one and the same is probably the most difficult problem which a faculty member contemplating active learning might face. My emphasis is on students becoming self-directed learners, so I focus on helping them develop personal resources to come to grips with material they are trying to master. I lecture only when I think it will do more good than harm. Wilbert McKeachie, author of *Teaching Tips: A Guidebook for the Beginning College Teacher,* claims that we do not need to lecture when concepts are

"As testimony to the effectiveness of this approach, we were able to teach considerably more than in the previous year without any student complaint about overload."

available in printed form at an appropriate level for our students. In general, print presents information in a form which can be covered more rapidly and in a way more accessible for retrieval than do lectures. Students using printed materials can choose their own rate of learning: they can review, they can skip, and they can vary the order. Lectures can, however, help students get up-to-date information, summarize materials scattered over a variety of printed sources, provide structures to help students read more effectively, and have value apart from their cognitive content.

I have also found that I must be very careful with evaluation of students working in learning groups. If grading is conducted in terms of a normal distribution, students are encouraged to compete with one another and are discouraged from helping one another. There is a great deal of evidence supporting the fact that students who study together and question one another are likely to learn more than those who work individually. I do not give students the impression that they're competing with other students for a grade. Instead I set up criteria that are noncompetitive (such as certain numbers of points or percentages of correct answers, or better yet, specific qualities which will determine grades) and are not reliant on the student's relative class standing. My most important objective is to develop students' motivation and skills for continued learning, problem solving, and application of course learning after the course is over. The testing and grading system I use, therefore, puts these objectives as primary.

The Rewards

Learning how to learn throughout life is a basic skill which I promote in every way I can. I believe that students will be empowered if they are allowed to use their strengths, and that questioning, talking, listening, experimenting, and observing are central to the acquisition of this basic skill. All should be encouraged in learning situations. Content is central to learning but many views should be presented for dealing with any problem, issue, concept or other matter to be learned.

We should trust students to sort things out and help them develop techniques for dealing with information. We should also help them learn to analyze a situation so they may discover what information is lacking in order to develop a rounded picture of what they are studying. A structure that supports students and guides them toward the desired outcomes without controlling them inappropriately is one of setting autonomy-oriented limits. Traditional teaching, where students read the textbook, listen to lectures, work by themselves on assignments, and try to outperform their classmates on exams, will not be as effective in achieving the goals of education outlined above as will group learning strategies.

The rewards associated with learning groups are many. For students, learning groups provide a useful means for developing transferable skills; students learn how to seek out information, how to learn and work collaboratively, how to define problems, how to design solutions, how to write and communicate effectively, and how to grapple with intellectual disagreement.

Students report that they like working with others in spite of some difficulties such as scheduling out-of-class meetings. Actually, students become quite adept at handling the day-to-day problems associated with working collaboratively with others. Students are able to manage larger, more complex and often more interesting problems without feeling overwhelmed; often they take the initative for their own learning beyond the limits of the assignments, and spend more time serving as resources for each other, sharing information, and producing high quality products than they do in other courses. Comparison with previous experience showed that students understood the material better and tended more often to go beyond the information given than when the courses were conducted in a lecture format.

In addition, there is considerable research (Johnson, Maruyama, Johnson, Nelson & Skon, 1981; Johnson, Johnson & Maruyama, 1983) which indicates that cooperative active learning is superior to competitive, individualistic learning, in which students work alone on their own set of materials at their own pace to achieve a preset criterion of excellence in promoting: 1) higher comprehension, understanding, mastery, and retention of facts, concepts, rules, and principles; 2) higher motivation to learn; 3) more rapid transition to higher stages of cognitive and moral reasoning; 4) more positive attitudes toward the subject matter being studied, classmates and teachers; and 5) collaborative competencies.

For faculty, the greatest reward is the response from students. Students often report that the Systems course, for example, is the first course in which they were encouraged to work with other students. They especially like the teamwork. Since teamwork is an important part of graduates' professional activity, it is important that they experience it in an instructional setting. The students' discussion and level of reasoning on the assignments clearly showed they were getting enormous benefits from their discussions of open-ended problems. It was stimulating to see students uncovering aspects of problems and algorithms which had been overlooked by students working individually in previous classes. As testimony to the effectiveness of this approach, we were able to teach considerably more than in the previous year without any student complaint about overload.

The work with cooperative learning groups at the University of Minnesota has shown that these procedures can be effectively applied to the education of college students. Students learned to work with one another more effectively; managed larger, more complex problems readily; reported that they liked the cooperative learning experience; and took the initiative for their own learning beyond the limits of the assignment (Smith, Johnson & Johnson, 1981).

Cooperative learning procedures have several important contributions to make to college education. The use of the cooperative goal structure approximates more closely the activity of real world employment and problem solving; allows students to tackle larger, more complicated, and often more interesting problems without feeling overwhelmed; allows students to serve as resources for each other, hence taking some of the pressure off instructors and teaching assistants; and allows students to expend more effort on sharing ideas and on producing quality products, and less on beating other students on performance measures.

Knowledge and skills are of no use if the student cannot apply them in cooperative interaction with other people. It does no good to train a student if he or she does not have the competencies needed to apply his or her knowledge and technical skills in cooperative relationships on the job, in the family and community, and with friends. The most logical way to emphasize cooperative competencies as learning outcomes is to structure the majority of academic learning situations cooperatively.

Where to Get Help

I'd like to emphasize that the books and articles of David and Roger Johnson provide clear procedures, helpful suggestions and research support for cooperative learning. The Cooperative Learning Center, located in room 202, Pattee Hall, has a large amount of material. *Learning in Groups*, edited by Bouton and Garth, also has useful advice on using learning groups. Goodlad's *Learning by Teaching* provides superb guidance on all aspects of tutoring. Rationales for active learning and additional benefits to students are described in Astin's *Achieving Educational Excellence*.

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Introducing Simulation and Role Play

Terrie M. Shannon

Simulation teaching strategies can be used very effectively with university students to achieve more active involvement in learning. Simulation in the classroom can be classified as one of four types: 1) role play, 2) simulation games, 3) simulation exercises, and 4) computer simulation. In all simulations, participants are given an opportunity to experience what a specific situation might be like and to practice how to behave in the given circumstances. All four types of simulation can help make abstract concepts more concrete, and thus more understandable, for students.

Role play involves spontaneous enactment of a given situation. In a simulation exercise, students are put into a position of physically feeling an abstract concept, such as discrimination. Simulation games provide opportunities for students to practice something without the penalties which might be involved in reality. Computer simulations include a wide variety of simulations currently available as software for microcomputers.

The four types of simulation differ in several ways. Role play and simulation experiences are less structured and are non-competitive. Simulation games and computer simulations usually are governed by specific playing strategies or rules, and they often include a reward or payoff to the "winners." The major focus of this chapter will be on simulation through role play. Uses of the other three types of simulation will be suggested at the end of the chapter.

One of the major advantages of simulation as a teaching strategy is that students are actively involved on an affective level as well as a cognitive level. Probably the most common reasons for using role play are to affect attitudes and to increase awareness of interpersonal problems and issues inherent in a given situation (Kozma et al, 1978). Role play can be used to teach content in the cognitive, affective, and psychomotor domains. Joyce and Weil (1980) state that the role playing model of teaching is extremely versatile, applicable to several important educational objectives: "Through role playing students can increase their ability to recognize their own and other people's feelings, they can acquire new behaviors for handling previously difficult situations, and they can improve their problem-solving skills."

What is role-playing? According to Kozma et al (1978) there are basically two types of role plays. In the first type, players relinquish their usual patterns of behavior in exchange for the role and patterns of another person. The role players attempt to speak, think, behave, and feel like the person they are playing. This allows the student to identify and empathize with other people and their problems.

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"... role play involves spontaneous enactment of a given situation."

In the second type of role play, the players retain their own roles and behavior patterns, but act as if they were in a different situation. This type of role play is useful for the training of specific interpersonal skills, such as counseling, interviewing, or handling conflict. Role playing done in this way can be used in conjunction with modeling. One person can demonstrate the particular behavior and students can then practice it in a role play.

How to Get Started

Some students are usually reluctant to play a role in front of the class in the beginning. It usually works well to start gradually and informally at first. For instance, if the topic were parent/child communication, you could have students work in pairs to enact a typical parent/child conflict. The teacher circulates among the pairs, unobtrusively listening to the conversations, and intervenes only if students need assistance.

After a few experiences with simultaneous role playing by the entire class working in pairs, it usually works well to ask for some volunteers to repeat their role play for the class, so the situation can be discussed as a group. It has been my experience that someone usually does volunteer. (On the rare occasions when there were no volunteers, I have asked specific students to repeat their role play situation for the class. I usually choose students who are outgoing, and whose role play will bring out specific points important to the objectives for the class.) It is often helpful to have two or three pairs of students role play the same situation for the class and thus illustrate that there are many possible solutions to most situations.

If the class is broken into learning groups, the students get to know the other students in their group fairly quickly. In this situation you can begin with simultaneous role playing then have the pairs repeat their plays for their learning groups.

There are two major advantages of having all students play roles simultaneously. One is that, instead of passively observing, all students are actively involved with the content of the class. The second advantage is that it is less threatening to play a role if no one is observing. Here the player can concentrate on the role itself rather than worry about the impression on an audience.

When students seem comfortable with role playing in pairs, the size of the group can be expanded to include four or five members. In many instances, it is helpful to assign one student in each group the role of "observer" with specific suggestions about what aspects of the role play to note. Following the play, the observer provides feedback to the players. Depending on the feedback received and the purpose of the play, it is sometimes helpful to allow time for the group to replay the situation. There are many variations of role playing including role reversal and cut-in role playing.

Role play is the most effective when the situation to be played is meaningful, emotional and intense. It seems to work best when the students are given some choices about the roles they will play. For instance, if the role play involves a parent/child conflict, the students can decide who will be the child and what the age and sex of the child and of the parent will be.

The analysis which follows the play is as important, if not more important, than the role play itself. The instructor needs to plan discussion questions carefully to develop the anticipated learning. If the discussion questions are replicated and distributed to student pairs or groups, there is more active involvement of students. Discussion of questions by the entire class can follow if time permits. If student answers are written, they can be collected for teacher response and/or grading.

The process the instructor uses to teach with role playing involves 1) selecting a useable incident or situation, 2) briefing the participants and observers effectively, 3) cutting off the role play at the point of maximum learning, and 4) analyzing and possibly replaying the roles. Each step is a skill that is fairly easy to learn. Suggestions for each are given below.

Joyce and Weil (1980) recommend the following for sources of situations for role playing: "Films, novels, and short stories are excellent sources, and problem stories or outlines of problem situations are commonly used. Problem stories, as their name implies, are short narratives that describe the setting, circumstances, actions and dialogue of a situation. One or more of the characters face a dilemma in which a choice must be made or an action taken. The story ends unresolved." Joyce and Weil describe four types of social problems amenable to exploration through role play: interpersonal conflicts, intergroup relations involving stereotypes and prejudices, individual dilemmas, such as value conflicts, and historical or contemporary social problems that need to be confronted.

The briefing of participants and observers can range from very detailed explanations to very vague or open-ended suggestions. Usually when students are not experienced in role play, more detail and structure must be provided when "setting the stage" for the play. As they become more accustomed to role play, students become more able to handle complexity. Usually the most helpful feedback to the players comes from observers well instructed in the aspects of the role play most important to observe.

The skill of knowing when to stop a play probably comes through experience. Klemer and Smith (1975) advise the instructor to "stop the role playing at a high point even if the students appear to want to go on." This disruption will make the discussion start much more quickly and emotionally than when the playing is 'finished.' Kozma et al (1978) suggest that the instructor stop the role play "if it becomes unmanageable or threatening to one of the players. The play should be stopped when the objective of the play is reached or otherwise after three to six minutes." My advice is for instructors to trust their own instincts here.

The value of role play as a learning experience depends upon the value of the analysis following the experience. This is largely determined by the skill with which the instructor leads the discussion of the play. One may focus on affective or cognitive areas, depending on the types of questions asked following the play. Discussion questions can include both affective and cognitive issues. Here are examples of general discussion questions for analyzing a play:

a) How did it feel to play this role?
b) How accurate were you at predicting the actions and reactions of the other players?
c) If the other players did not act out their roles in the ways you expected, how did you want them to react?
d) What other approaches to resolving the situation could have been used? What will be the consequences of these?
e) Would other approaches or decisions have been more effective? more satisfying? more realistic?
f) Were the actions and feelings of the role players typical of other people in similar situations?
g) How realistic was the situation as played? If it was not realistic, or seemed over-simplified, what other factors would provide a more accurate portrayal of the situation?
h) What generalizations about human behavior can be drawn from this play?

The discussion questions must be related to the learning objectives for the lesson. If the objectives were not accomplished by the play and ensuing discussion, it may be desirable to replay the roles in a different way. The situation could be replayed with the same students playing the same roles, the same students reversing roles, or with different students playing the roles.

Sample Applications

Some of my most successful role playing experiences have focused on family relationships and parenting. One example is based on Virginia Satir's work in identifying and describing communication styles. I have two goals for students: 1) to be able to identify the five communication styles when they see examples of each, and 2) to experience how it feels to use the different communication styles. The first goal could be achieved by a lecture or a film demonstrating the communication styles of blaming, placating, distracting, being super-reasonable, and leveling (Satir, 1976). Role play is the logical teaching strategy to accomplish the second goal.

Students are divided into groups of five and given assignments for both a role and a communication style (e.g., mother-placator, father-blamer, teenage daughter-super-reasonable, younger son-distractor). The fifth person acts as observer to be sure the players remember to use the assigned communication styles. A problem situation is described and the "families" try to resolve the problem, each using his/her assigned communication style. The discussion following the play centers on how it felt to be in the role of blaming, or of placating, etc. Players describe what they liked and did not like about each of the communication styles. When all students seem to understand the various styles well, we

discuss the "solutions" each family reached and how satisfactory these are likely to be.

The final part of the class involves replaying the same family roles and the same problem a second time, this time with all family members using the communication style Satir calls "leveling." The discussion again centers on how students feel when leveling, and we compare the effectiveness of the communication in the first and second plays. This technique has been successful in accomplishing both of my goals for the class.

Another successful role play experience has been used to develop more positive attitudes toward elderly people. This play involved more elaborate preparation, including "setting the stage" for the role play, with music, poetry, photographs, and a film. A song by John Prine, "Hello in There," was used to describe the life of an elderly retired couple; a variety of poems was read depicting scenes in the lives of old people. Visuals included photographs of elderly men and women of many racial and ethnic groups and a film entitled "Minnie Remembers" which shows an old woman in a nursing home and flashes back to the time when she was a young wife and mother.

Students were then given a letter written by Minnie, expressing her deep loneliness and her need to be recognized. They were asked to play the situation in small groups to show how they would respond to Minnie. We did not discuss this play as a class, but most students were still discussing it in their small groups even after class. Many of the students responded to this play in their journals and some seemed to be deeply affected. Several said they visited or phoned or wrote to their grandparents or parents as a result of this class experience. I am not certain what factors were crucial to the effectiveness of this particular play, but the goal of developing a sense of empathy toward elderly people was certainly attained, at least for a time. Here, again, role play had the potential to make a very powerful emotional impact on students.

Role play has succeeded as a teaching strategy in all of the social sciences and in a wide variety of topics. Creative instructors in almost any area can think of ways to make learning "come alive" through use of role play or other simulations.

"... role play may be helpful in the attainment of higher levels of cognitive development."

Many other types of simulations exist, however a detailed discussion of them is beyond the scope of this chapter. Nonetheless, I would like to encourage people to consider experimenting with simulation games and computer simulations.

Simulation games allow students to plan strategies and make decisions that are similar to those in real-life situations. Simulation games usually involve competing groups of players and usually provide rules of play.

"... one of the most important changes that I see in students as a result of role playing is a change in their ability to understand other people's points of view."

The number of computer simulation games has been increasing rapidly and the quality of the games has been improving. A few examples from recent journals will illustrate the types of games in use at the university level. An article by Kim M. King in *Teaching Sociology* (April, 1985) includes a description of a computer game entitled "Sex Roles" designed for college sociology classes. The spring 1985 issue of *Journalism Educator* describes two microcomputer games developed to teach pre-journalism students to locate and evaluate information used in mass media messages. In *Teaching Political Science* (summer 1983), two computer simulation exercises are explained. One allows political science and foreign language students to play national decision-makers; the second is an international futures simulation where students debate demographic, economic, energy and agriculture issues. These are just a few examples of the many simulation games available.

Challenges and How to Deal with Them

University students who are used to sitting passively through lectures may resist at first the effort it takes to become more actively involved in learning. Using a gradual progression from simultaneous role playing in pairs to role playing in small groups to role playing finally in front of the class seems to make this teaching strategy less threatening and more enjoyable for students.

For a variety of reasons, some instructors do not feel very comfortable using role play. One reason may be that he/she has less control over the way the class will go using the role play method as compared with a lecture method. It takes considerable experience to predict accurately how a particular group will respond to a given role play situation. Instructors who like to have a quiet, orderly classroom may dislike the noise and confusion that occur in role playing. According to Kozama et al. (1978), instructors who characterize themselves as "person-centered" or as "intellect-centered" are more likely to function well with role play. Instructors would not find role play a very efficient way to deliver or demonstrate knowledge.

Some instructors may not use the role play method because there has been little evidence of the superiority of this teaching method over more traditional methods of instruction. Much of the research which has been done has focused on effectiveness with elementary or secondary level students. After a review of the sparse literature related to role play at the university level, Kozma et al. (1978) state, "Thus, it seems that role play is useful to practice interpersonal skills or to explore different attitudes, but attitude changes may not be stable and do not necessarily translate into behavior."

Just as the characteristics of the instructor may determine his/her attitude toward role play, so the characteristics of the students may affect their preferences toward different teaching strategies. Many recent research studies have identified various aspects of students' learning styles. Some of the factors which affect a student's ability to benefit from a particular situation include the stage of cognitive development, the learning modes preferred, and the way information is processed by the brain. For example, students who prefer abstract learning would be more likely to benefit from role play experiences than students who prefer the "concrete and sequential" presentation of class content.

One additional potential trouble area for role play should be mentioned. If over-used, role play is likely to lose its teaching effectiveness.

The Rewards

The major rewards of role play are the excitement and active involvement it brings to the classroom. Both cognitive and affective learning seem to result from this teaching method. Students have been very positive about their role play experiences. From the intensity of the role playing and the discussion following, it is clear that students are emotionally involved with the content.

The role of the instructor changes in a positive way when role play is used. The class is more student-centered while the instructor acts as explainer, coach, and facilitator rather than as the source of all knowledge.

One of the most important changes that I see in students as a result of role playing is a change in their ability to understand other people's points of view. David and Roger Johnson (1978) state that "one of the most critical competencies for cognitive and social development is social perspective-taking. Social perspective-taking is the ability to understand how a situation appears to another person and how that person is reacting cognitively and emotionally to the situation. Perspective-taking is a central process underlying almost all interpersonal and group skills. It has been found to be related to effective presentation of information, effective comprehension of information, the constructive resolution of conflicts, willingness to disclose information on a personal level, effective group problem-solving, cooperativeness, positive attitudes toward others within the same situation, autonomous moral judgment, intellectual and cognitive development, and social adjustment."

In addition to helping students develop personal and social skills, role play may be helpful in the attainment of higher levels of cognitive development. David Hunt (1970) has identified four levels of conceptual structure according to the number of dimensions people use in relating to the environment and to the interrelationships of these dimensions. An individual at a low complexity level uses categorical, absolute thinking, while people at high complexity levels can see complex situations from a variety of points of view and can simultaneously weigh the effects of different viewpoints.

According to Hunt and others, the best way to help people move toward greater complexity and flexibility is to expose them to training which pulls them to the next higher level of development. For students at the two lowest levels, the training should help the student to recognize that different people have different vantages from which they look at the world, and to begin to take on the points of view of others, seeing how they operate in situations. Role play experiences provide just such opportunities for students.

Where to Get Help

The authors I have found most helpful for describing role playing and simulation games are Joyce and Weil (1980), Klemer and Smith (1975), and Kozma et al. (1978). Other good references include Milton (1978), Abt (1970), and Taylor and Walford (1972). A helpful journal on simulation games is *Simulation and Games — An International Journal of Theory, Design and Research* (Beverly Hills: Sage Publications). The best directions for and examples of simulated experiences can be found in: Pfeiffer and Jones (various dates).

Structuring Controversy in the Classroom

Deborah Deemer

Controversy in the classroom can enhance student motivation, mastery of the material, and skills in communication and conflict resolution. Structured controversy can enter the classroom through discussion or debate as part of the formal course curriculum. Even if you limit student participation to a question and answer period, the door is open to individuals who want to challenge your opinions or disagree with the most basic information you hope to get across. Controversy is even more likely when students are asked to participate in group discussions, solve problems together, or work in group projects. In any event, controversy is almost inevitable when students become actively involved in the learning process.

But while controversy can facilitate learning and personal development, it also has the potential to block constructive work and foster negative feelings. Learning to deal with controversy takes patience and practice, but when handled effectively it is stimulating, builds healthy, positive relationships, and fosters creative solutions to problems. The ideas which follow can help create controversy that is fun and productive, and help resolve interpersonal conflicts that may arise whenever people work together.

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How to Get Started

1. *Determine the appropriate format for the discussion.* N.R.F. Maier (1963) believes there are only two general classifications of controversial discussion: a problem-solving discussion and a persuasive discussion (or debate). In a problem-solving discussion, students attempt to formulate a workable solution by studying various aspects of the problem, identifying barriers and various avenues to solve the problem, and developing a solution which takes all relevant information into account. In contrast, in a persuasive discussion, students begin with preformulated solutions and seek information and opinions that will justify their position. Whereas in the problem-solving discussion students work to resolve their differences by formulating an integrative solution, in a persuasive discussion they start with predetermined solutions and attempt to solidify their initial perspective.

   The debate format tends to motivate students more than problem-solving sessions. It would be most useful in your classroom when you want students to become aware of certain facts and opinions and to apply them in a particular situation. However, even with role reversal and the assignment of a final group report that covers both perspectives, a balanced integration of material is rarely achieved. When students succeed in attempts to integrate the perspectives, you probably should question whether the topic that you choose was of sufficient interest.

"Controversy in the classroom can enhance student motivation, mastery of the material, and skills in communication and conflict resolution."

Students find problem-solving discussions relatively less stimulating, but a fuller examination of the problem, with an eye towards integration, is facilitated by this approach.

2. *Choose an appropriate topic.* You can either select a topic for discussion or encourage students to raise questions and express opinions about material already covered. If you want students to discuss a topic of your choice, you can stimulate interest and increase participation if you select an issue that involves attitudes; then introduce the topic in a way that makes the issue personal or concrete.

3. *Provide specific instructions.* You facilitate controversy when your statement of the task is specific. Maier recommends that you structure the task to separate the process of generating ideas from that of evaluating them. For instance, you might want to provide instructions similar to the example below:

   > Your group needs to identify the four best arguments for outlawing the use of IQ tests. First you need to share your views, and make a list of all the arguments you can identify. Don't be critical or evaluate the arguments that are proposed at this time. Put your energy into helping each other identify and communicate ideas, regardless of how absurd they may sound. When your list is relatively complete, then go back and select the four best arguments. You should be prepared to report your conclusions to the class in about thirty minutes.

Talk about the "rules of constructive controversy" prior to the debate and remind students of them if the discussion gets out of hand. The following principles outlined by Karl Smith serve as a useful handout for students:

- I am critical of ideas, not people. I challenge and refute the ideas of the opposing pair but I do not indicate that I personally reject them.
- Remember, we are all in this together, sink or swim. I focus on coming to the best decision possible, not on winning.
- I encourage everyone to participate and to master all the relevant information.
- I listen to everyone's ideas even if I don't agree.
- I restate what someone has said if it is not clear.
- I first bring out all ideas and facts supporting all sides, and then I try to put them together in a way that makes sense.
- I try to understand all sides of the issue.
- I change my mind when the evidence clearly indicates that I should do so.

5. *Provide sufficient time for discussion.* The amount of time allocated for the discussion depends on the complexity of the issue and size of the group. What's important is that you allow enough time to resolve differences.

6. *Help students reformulate the question if the debate becomes too heated.* If students argue heatedly and it seems they are unable to get past their initial perspectives, you should intervene and help students reformulate the problem. If students continue in a competitive struggle, there's never enough time to reach a solution, and they are likely to harbor negative feelings. Therefore, it's important to have students explore requirements of the problem and draft a new problem statement if the discussion becomes deadlocked.

7. *Try having students reverse sides and argue from the opposing position.* It can be very useful to have students restate the arguments of their opponents and present any new arguments that come to mind. This exercise may help to diffuse any prior animosity while it provides practice in good conflict skills. However, don't be discouraged if students are unreceptive and find it difficult to divorce themselves from their initial position. Even the most skilled individuals have trouble with this one.

The procedures for organizing a formal debate are not dramatically different from those outlined for informal debates. However, the following steps may prove useful additions.

1. *Assign positions. If student opinion is not equally divided between the two sides, assignments can be made by the flip of a coin.*

2. *Help students prepare for the debate.* Each group should pick one or two students to represent them in the debate. Make sure the recruits volunteer; it's no fun if people are railroaded into participation. Emphasize, however, that all students are responsible to help their representative prepare arguments for use in the debate. The speaker is only their mouthpiece and shouldn't be expected to shoulder all the work.

   Students will usually help if you structure their participation. I recommend that each student get a pack of notecards and record each argument she or he comes across. Group meetings are sometimes difficult to arrange, but it's easy to hand the speaker a stack of arguments on the way out of class. It also helps if you set aside at least part of one class period for students to organize their arguments and develop a strategy.

   Students should organize the arguments by topic. In this way they can assess where their position is strongly defended and identify weak areas that require more research. Making a file will also help them quickly build a necessary counter-argument when the debate is underway.

3. *Establish the procedures for the debate.* On the day of the debate have each group sit together so the students can readily exchange ideas. A few minor details can add flare, drama and fun. Place a formal lectern in the front of the room with a pitcher of water and a glass for each speaker nearby. List the names of the speakers on the board in the order of presentation and announce each one at the appropriate time. Invite a few colleagues to serve on the panel of judges and be sure to have a time-keeper. The time-keeper should notify each speaker when there are only 30 seconds left to complete his or her argument. And while reinforcing the efforts of all participants, announce a winner. Students are apt to be disgruntled if the debate ends in a draw, so make sure one side comes out ahead, even if by only a fraction of a point.

Challenges and How to Deal With Them

Each of the procedures outlined above has its own set of problems. It seems that every time a solution is worked out for one issue, a new difficulty arises to replace it. However, students are almost always patient, understanding and helpful in the resolution of unexpected problems. This section should help you head off some of the more common ones.

First, when students participate in a full class discussion, they may wander away from the topic you want them to focus on. When a question is tangential or at too high a level, you can tell the inquirer you prefer not to address that particular question at that time; recommend a visit during office hours to pursue the issue. Or you can schedule a time for students to generate questions or problems.

Don't answer each question as it is raised. Instead, summarize questions on the board. In this way you don't evade questions but facilitate the collection and communication of problems. Then, at an appropriate time, have the students themselves explore those problems which are of common interest. In lecture, for instance, you can provide students with relevant background material, but let them assume responsibility for solving their own problems.

If students work together in groups, you should also be prepared for interpersonal problems and outbursts of anger and frustration. Complaints are common regarding group members who won't do their share of the work, or who dominate the discussion in a direction that others don't support. If you are approached with these or similar problems, don't take sides. Your first impulse may be to sympathize and try to calm the complainant down, or to disagree and accuse him or her of being unreasonable, but either approach is apt to create even more trouble.

According to Maier, you should listen, but don't react or evaluate. Let the students express their feelings. Your role is to understand and help the persons talk about how they feel. After the students have fully expressed their feelings you should facilitate the collective problem-solving process. If the students seem stuck, ask questions like: "What is likely to happen if you act differently?" "What will you do if that doesn't work?" "Is it possible that someone might object?" Be careful not to pry, and ask questions in a way that doesn't imply criticism or shoot down an idea. The atmosphere should be one of joint exploration.

The Rewards

Controversy can add excitement to the classroom and help build positive relationships among students and with the teacher. When disagreements arise in the discussion, interest is aroused, and students are stimulated to seek information. Controversy can also facilitate problem-solving processes and help establish skills and motivation for independent inquiry.

"The debate format tends to motivate students more than problem-solving sessions."

Where To Get Help

The suggestions above are intended to help you increase the level of controversy in the classroom and manage it in a constructive way. Many of its ideas are drawn from the work of N.R.F. Maier whose books can well provide a fuller understanding of the processes of controversy. The debate program of the Speech and Communications Department is a useful resource for setting controversy in the formal curriculum.

Using Active Learning in Large Classes

Thomas F. Brothen

Large classes, heavy teaching loads, research and publication demands, service responsibilities, and a lack of knowledge about teaching methods mean that many professors continue to do what generations of professors have done before them — lecture. But there are alternatives. This chapter describes the class organization, method, and results of using active learning strategies in a basic psychology course in which 270 students enroll each quarter. Central to the system described here is the use of *learning groups*. Learning groups are a recent addition to a teaching/learning system that has been developing in the General College since the early 1970s when Professor Henry Borow introduced active recitation into his basic psychology course.

Briefly, learning groups require students to work together on tasks that teach them concepts or skills. In this way, an active discovery process takes place as students use their own and others' resources to work through problems or review exercises. But anyone who has used learning groups knows there are problems to overcome if the process is to have the intended effect. An approach which deals with these problems is detailed below. Perhaps its description will serve to stimulate others to adopt active learning strategies in their classes.

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How to Get Started

There are several factors which should be considered when developing active learning methods for large classes. Following the guidelines below may help you avoid potential difficulties.

1. *Find appropriate classroom space.* When using learning groups or any active learning strategies with large classes, you will find that an immediate, obvious problem is space. Most often, students in a large class fill the room from aisle to aisle. In the face of bolted down auditorium chairs, it is not a perfect solution to divide the class into groups. I have divided my large class into 30 student segments which meet two days per week in laboratory/recitation sections. Here the problem becomes more manageable — mostly because rooms that accommodate 30 students are common and are usually equipped with moveable chairs.

2. *Use teaching assistants if possible.* Without good teaching assistants, it would be difficult if not impossible to accomplish a great deal of active learning in large classes. A lone professor can easily lecture to 250 students. But if the classroom methods involve active learning and students are completing exercises, it is difficult for one individual to provide adequate feedback. Ideally students should be split into sections in smaller rooms. With this arrangement, extra personnel are almost essential for proper monitoring of group activities. I

have used undergraduate teaching assistants and tutors with very good results. Graduate student assistants are desirable but not absolutely required.

3. *Establish learning objectives.* Clear, specific course objectives must be developed and translated into specific student activities. It is relatively easy to state objectives for a lecture course: a body of knowledge is identified and students are required to learn it. But when students are also supposed to be able to use that knowledge, specifying objectives becomes a more difficult task for the instructor. The main task is to decide what you want students to be able to do with what they are learning. For example, I expect my psychology students to be able to interpret data tables based on human behavior, so I have them complete several projects in which they tabulate data they have gathered on their own behavior.

4. *Write the syllabus to give students as much guidance as possible.* Because active learning, particularly in group settings, is new to many students, you may find it useful to prepare a more elaborate syllabus than usual. First, it helps students to have a daily guide to the activities which will take place in each class period, whether lecture or group tasks. You might also want to find room in the syllabus to explain what will be expected of each student in his or her group. Finally, it is important in an active learning setting, as in any other class, to make students aware of what criteria will be considered for grades. In a class using group activities as part of the grading system, students may be concerned about what percent of their grades will be individually based and what portion will rest on group-related work.

5. *Prepare practice materials.* If you decide to use active learning strategies, you have to generate activities for the students. Instructors cannot just tell students to "discuss the material." If you don't provide specific exercises for students, you will be disappointed with active learning. Printed assignments seem to work best because they help prevent problems of misinterpretation. After several years of experience with handout materials, I currently use a student study guide which I wrote specifically for my course.

6. *Use the students themselves as resources whenever possible.* In a large class the sheer number of students affords the opportunity to use the students themselves as a source for survey data or behavioral observations. Small groups can then be assigned the task of using the data, and in a session of the entire class, various approaches to the data can be discussed and compared. In this way, students gain a "hands on" experience with the research process and can see for themselves that sometimes researchers take different approaches to making inferences about the same information.

7. *Provide feedback.* Perhaps the most important aspect of using active learning methods in a large classroom is their potential for allowing instructors to provide constant and immediate feedback to students. Because students in the large classroom can be separated into smaller groups, generally the instructor has a better opportunity to get to know the students and to speak to the groups on a more personal level than might be possible if the class is held as a large lecture session.

Taking advantage of the opportunity to provide feedback is important. Although many have had some exposure, most students you will encounter will be unfamiliar with active learning. Thus, they may be uncertain, as individuals or as groups, that they are proceeding as they should be. Supplying feedback helps maintain student motivation and is likely to improve overall results.

"In a large class the sheer number of students affords the opportunity to use the students themselves as a source for survey data or behavioral observations."

Sample Applications

A detailed description of my class will show how I have dealt with the issues raised above and, I hope, demonstrate some ways to structure a large class to achieve active learning. Students attend class together on Monday, Wednesday, and Friday and break into nine laboratory/recitation sections of 30 on Tuesday and Thursday. Primarily they are students in the General College, the general education unit of the University. The College attracts people with a wide variety of academic records, abilities, and interests.

The Wednesday class session is the only one that might be called traditional in form. This is the only lecture time — an overview of the nine weekly units. The objective of this lecture is not to transmit information but to help students develop a structure they can use to understand material in that week's unit. Key concepts are related to each other and to concepts from other units.

The Friday session is devoted to a weekly quiz and review. Students complete a 15-item multiple choice quiz within a 20-minute time limit. After the quizzes are collected, students are shown the test items on a screen while reviewing their answers on a quiz record form. Items are explained and correct answers given. Students thus receive feedback immediately after they take the quiz. My teaching assistants and I are available to discuss items after the reveiw session.

The other class sessions are more explicitly organized around active learning principles. The Monday and Tuesday sessions are devoted to data projects. This element of the course is similar to, but does not duplicate, the content of traditional psychology laboratory courses. The intent is to give students an understanding of what most psychology instructors would agree is central to the field — the empirical approach to understanding human behavior. The projects are organized in a sequence familiar to psychologists.

On Monday, students are introduced to a concept through a mini-lecture by the instructor and then take part in an experiment or complete a questionnaire to produce data. For example, before beginning a perception project requiring identification of difference thresholds produced by a light apparatus I constructed, I explain the threshold concept. For a project demonstrating serial position effect in memory, students are asked to learn lists of nonsense syllables flashed on a screen with a slide projector. Students take part in these research activities as both subjects and investigators, and the research method thus becomes clearer to them.

On Tuesday they work in four-student learning groups to tabulate their pooled data with the help of teaching assistants and student tutors. They analyze these results and discuss how they will answer the project discussion questions.

Before the Thursday group sessions, students are expected to complete project questions and review exercises (fill-in-the-blanks, study questions, and practice quizzes) from a workbook I designed specifically for this course. Turning in a complete set of correct answers by the beginning of the Thursday session earns the student two points (out of 300 total course points); an answer sheet that is 95 percent correct earns one point. A completed answer sheet also qualifies a student for two additional points if his or her group correctly completes a matching exercise. The matching exercises consist of 20 statements about the unit's material to be matched with 20 key concepts and are graded in the same fashion as the fill-in-the-blank questions (two points if all 20 are correct, etc.). Students are allowed to use their books or notes as resources in doing these exercises. Later, in small group sessions monitored by laboratory teaching assistants or student tutors, students receive yet another point if they contribute to the group's discussion of the study questions.

In all of this, high standards are maintained in grading and points are awarded to reinforce the behavior of actively working with course material. To establish a sense of common fate and to encourage cooperation, students' grades are dependent in part on their group's performance.

Because there are a number of activities and assignments associated with the course, a comprehensive syllabus is given to students so they can be prepared for each class session. The syllabus contains a calendar of daily class activities, a statement of class procedures, and full information on grading policies, including the total points necessary to achieve particular grades.

Teaching assistants and tutors are central to this type of instructional system, and care is given in providing them with training and written guidelines to assist them with their work. Teaching assistants for the course are provided grading guidelines for each of the student exercises and projects as well as a set of explicit procedures to be followed in the laboratory sessions. In addition, I supervise an ongoing training program for the assistants designed to address any problems which might arise during the quarter.

Student tutors assist the teaching assistants in laboratory sessions. The tutors are undergraduate students who previously had taken the course and received high grades in it. Only those students who showed interest in the class material and in working with other students are selected. They attend a weekly seminar on teaching and learning for which they receive four credits. The tutors assume responsibility for one laboratory section (one or two tutors per section) and spend several weeks in their seminar reading and discussing material focusing on issues in teaching and learning; they examine their roles as tutors in the laboratory sessions. Later they work in learning groups to research a topic of their choosing (e.g. compulsive behavior, child abuse, TV and behavior, etc.) under my guidance. Each group then does an oral and a written presentation on its chosen topic.

The teaching assistants and student tutors are important for several reasons. TAs and tutors are able to provide immediate feedback to the students in their learning groups. Teaching assistants can be instructed to return exercises and projects as quickly as possible and with extensive comments. In group sessions, TAs can serve as moderators helping to facilitate group discussions. Tutors are also helpful in advising students because they are available while students are working and, as peers, are relatively approachable and non-threatening to students who might be reluctant to seek out the instructor or teaching assistants. They may also serve as positive role models for students because they have already succeeded in the course.

Challenges and How to Deal With Them

Some faculty may be initially uncomfortable with active learning because it requires giving up the role of exclusive spokesperson in the classroom. Teaching assistants and tutors become more central in class activities. Students may even attribute to the textbook author exercises which the course instructor slaved to create! On a recent class evaluation, a student of mine commented that the course instructor got paid for doing "nearly nothing." But changes in the role which faculty members play in the classroom have been evolving for some time. A pioneer in the field of psychology, E.B. Titchener, was reputed to parade into his classroom in full academic regalia, graduate assistants at his side, while students stood at attention until he began lecturing!

In addition to changes in the instructor's role in the classroom, students quickly recognize change in their own roles as classroom participants. Some students will invariably complain of overwork or of the irrelevance of the work you're making them do. Many students truly believe that education means merely absorbing information, and they will expect the instructor to pump (lecture) the material into them in the manner to which they are most accustomed; they are simply not used to "working" in class.

The active learning class provides a stark contrast with the environment with which most students are acquainted. When they leave classes using active learning exercises, students often complain of being tired. One even complained to me that at least he could sleep during a lecture! You will find that even the most initially reluctant students generally adapt to the process in the long run and come to appreciate the value of the active learning process.

Faculty using active learning strategies may also find departmental colleagues less than ideally supportive in the beginning. Some may suggest that active learning approaches provide an easy way out and that students need to learn from the instructor — not each other. (I sometimes ask them about the number of students in their lectures who are sleeping, talking, looking out the window, etc.). Again, however, in the long run most will recognize that students are coming out of active learning classes more enthusiastic and more highly motivated.

Learning groups may pose another problem, particularly in large classes. Students are used to surviving (or prospering) on their own, and some (often the better students) are reluctant at first to have their grades dependent on the work of other students. Forcing group members to share some degree of common fate fosters cooperative interaction. I tell students that unless they plan a career as a lighthouse keeper, they had better get used to working in groups. And in the long run, students seem to realize that they are learning more about the substantive course material by working with other students as well as learning more about other people in general.

The Rewards

Active learning offers many rewards for both students and instructors. As measured by end-of-course evalutions, student response to these methods has been very positive. But the most telling comments have come to me personally from my best students. They express gratitude at having been able to take the course because they received so much individual attention and learned a great deal. Exam performance has improved somewhat over the traditional method of teaching the course but, more importantly, students are doing much more than simply marking answers on answer sheets. They are now better able to use the facts they have learned

The side benefits to students with this approach are also important. They learn how to work with others and are able to develop their communication and study skills. They also assume new initiative in the course. While it is often easy for students to walk into a lecture not having read the day's assignment, it is more difficult for them to come unprepared to a group session that demands everyone's help to complete an exercise.

"Perhaps the most important aspect of using active learning methods in a large classroom is their potential for allowing instructors to provide constant and immediate feedback to students."

Faculty who incorporate active learning strategies into their courses will be amply rewarded. Active learning is in many ways less stressful than lecturing. Being "up" to deliver interesting and animated lectures each class period is a strain; it is often disturbing for instructors to know that a headache or cold has resulted in hundreds of students getting less than their "money's worth" out of a class session. On the other hand, an active learning approach is less subject to temporary conditions such as illness or the press of other responsibilities.

All this does not mean that using active learning strategies results in less work. Indeed, there is actually a net gain in workload. But the additional effort is rewarded when you see every student actively involved in what you are trying to teach them.

Where to Get Help

Aronsen et al. (1978) describe a classroom technique that requires students to gather the pieces of a "puzzle" independently and then work in groups to assemble them into a final product. Each student is involved in the effort because he or she is responsible for an important part of the puzzle, and group cooperation is required to complete the tasks.

Bouton and Garth (1983) present analyses of the use of learning groups in a wide variety of settings and with different subject matters. Brothen (1984) describes three exercises used in the class described above. Johnson et al. (1981) review a decade of research on cooperative learning.

Finally, I invite anyone interested in the issues discussed here to contact me. I will be glad to give advice, encouragement, help, or solace as it's needed. I learned many things the hard way — by trial and error. Perhaps I can help you avoid some of the pitfalls.

Training Teaching Assistants to Use Active Learning Strategies

Donald Ross

Most departments at the University hire graduate students to perform teaching duties. The motives for doing so vary, but they always include the desire to help graduate students pay for their education and the idea that some practice teaching experience will help when the student gets a teaching position in a university or college. Graduate teaching assistants' (TAs) duties range from full responsibility for teaching a course to minor, behind-the-scenes jobs such as grading exams and papers. With full responsibility for the class, the TA helps the department and the University by providing relatively inexpensive instruction. With lesser responsibility, the TA helps individual professors deal with large numbers of students who are enrolled at the University, especially at freshman and sophomore levels.

Departments vary widely in the attention they pay to the training and duties of their teaching assistants. Some treat them as they treat new professors: the assistants get a copy of the textbook, a standard syllabus, and a grade book. Other departments invest considerable time orienting new TAs to their philosophies and practices, and they actively arrange regular contact between professors and TAs through staff meetings or seminars.

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The remarks in this chapter are addressed to people in departments which offer something for their TAs some way between the extremes I have just described. I assume that the teaching assistants have partial responsibility for direct contact with students, e.g., in regularly scheduled recitation sessions where the professor is not present (except, perhaps as an observer). I also assume that the department conducts at least a few hours of training and orientation for new assistants.

The main message I hope to convey is that, by careful and enthusiastic use of training sessions, we can help new teachers do a job that will benefit their undergraduate students and give them experience and confidence so that they will teach as well as possible after or while they earn their degrees. By building TA training programs on concepts of "active learning," we can both model and sponsor classroom attitudes which we approve.

How to Get Started

First, recognize that master's or doctoral candidates are not very much like the students they will teach. They are unusual in their achievements as undergraduates: they did well in most of their courses; they had well-defined and academic career goals; they wished to be like their professors in many ways. To a significant degree they need to be reminded of the students who sat next to them in introductory courses, those who went on to major in something else, those who got Cs, and those who dropped out of college.

Second, recognize that graduate students, especially those whose undergraduate experience came from a large university like Minnesota, are getting an exciting and new kind of education. In all graduate courses, but especially in seminars, they are in an environment where they can talk with a professor who will listen attentively, who will respect their ideas, and who will go out of his or her way to foster intellectual growth. In short, new graduate students benefit from active learning, perhaps for the first time since they were the stars in their high schools.

"In an important way, opening up the undergraduate class to students' voices is parallel to what the professor is supposed to be doing to help teaching assistants learn their craft."

The training of new teaching assistants can be seen as channeling the graduate students' energies to benefit the students they will meet. Of course, the new TAs are insecure about their jobs, but for most of them, all they need is their mentors' endorsement and a bit of practical advice about how to use their time.

In the training sessions that we have used in Composition for many years, and that we tried for the first time in English under a Northwest Area Program on Active Learning grant in 1984, our major approach was to model the teaching attitudes and behavior that we wish the TAs to have. In both Composition and English, writing and speaking are central activities. Since speaking is easier to change, our training begins with talking: we have the TAs talk a lot, to each other and to the professor, about everything relevant.

Sample Applications

In training TAs in English, we asked new TAs to read brief literary works before the sessions began. In the first hour I lectured about one work for about 20 minutes, then asked the TAs to form groups of four to evaluate the "mini-lecture." The groups selected people to report on their evaluation, to suggest improvements in the lecture, and to comment on the general atmosphere of the experience (Were they bored? Did they take notes? Was the lecture illuminating?).

This sort of introduction can easily be emulated in departments where the chief teaching activity is quite different from the explanation of literary works. For example, where case studies or problem solving activities are central, the training director could begin with a relatively formal presentation, followed by the same kind of debriefing I just described. The point is to have graduate students experience as directly as possible what undergraduates experience in a typical class session and, crucially, to reflect on that experience.

After the lecture format, I went through two other models — first the recitation, then the small group. In modeling the recitation, I began by asking for volunteer answers to my questions, then pointedly called on those who had been silent. In the debriefing we noted differences and I sought reactions and tried to make the TAs sympathetic to the social and psychological tensions of the recitation classroom. Since the TAs would probably use the recitation model for their first teaching, this round was the most obviously relevant.

While the small "learning group" is probably the best medium for teaching at any level, it is the least traditional. Professors are familiar with it only in their best graduate seminars, and they tend not to think of it in the context of large undergraduate courses. For our new TAs, we set up small groups from the start to help graduate students get to know each other and to encourage them to work together. During the modeling stage of the training program, each group was given a different question about a literary text to discuss and report on.

In comparing the lecture, recitation, and small group, the TAs became aware that they had been most active in the small group, where their views had been most diverse and they had a greater sense of ownership over the questions they had raised. The difference was most pronounced when, at the end of the training session, the TAs were asked to propose essay exam questions for the three works. Questions based on the lecture text were uniform, and they essentially were limited to the issues it had raised in the lecture. The groups had much more difficulty in arriving at consensus about the good questions for the small group text, and the diversity of their suggestions began to reflect the complexity of the literary work.

We have also sponsored a variant of the learning group model for TAs to try out when they go to work for professors in regular literature courses. In the smaller recitations, and even in the large lecture, it has proven feasible to spend part of the class time establishing informal working groups of 4 to 5 students. We have used these for discussions of specific literary questions ("How is setting an index of character in the story read for today?"). After small group discussion of 15 minutes or so, the students write out their individual answers, an exercise which serves as a quiz. Alternatively, the small groups' discussion can be the stimulus for a regular, full-class recitation. By going around the room, overhearing the discussions, the professor and/or TAs get excellent insight as to how well the students understand the question and its implications.

Challenges and How to Deal With Them

Both the professor and the teaching assistants share concerns about using small groups and active learning. Even after modeling the three classroom environments, the TAs were inclined to rely on the lecture. First, it was a format they had seen most often. Second, it gives the clearest feeling of control, both control over interpretation of the literary text and control over what happens in the classroom. Third, discussion by students seems to be less "efficient" than a well-crafted lecture.

"While the small 'learning group' is probably the best medium for teaching at any level, it is the least traditional. Professors are familiar with it only in their best graduate seminars. . ."

It should be obvious from the previous discussion that we tried to promote and encourage small group activities, both by forcing the new TAs to spend some time doing them and by the general attitude that we tried to convey. Also, by trying to give the TAs some practice and some confidence that they could be in a classroom with several small group discussions going on concurrently, we tried to get people past the fear that total chaos and anarchy would result.

The issue of control over interpretation of literary works happens to be under heated debate among literary critics. Thus, to raise questions is relevant and to ask beginning graduate students to explore the topic both in theory and in practice is important. Clearly, active learning works against the idea of the teacher-centered classroom, and it does force students to listen to each others' views on the texts which are in the syllabus. In an important way, opening up the undergraduate class to students' voices is parallel to what the professor is supposed to be doing to help teaching assistants learn their craft.

Finally, it is long in the tradition of literature departments that we value class discussion and we lecture but reluctantly. Thus, there is a general attitude throughout the department that lecturing is not the best way to teach our subject. Even by dividing up our largest courses into separate recitation sections, we still wind up with 40 or more students in [illegible]. We hope that expanding TAs' confidence and experience will help them become [illegible] new classroom resource.

The Rewards

By introducing new teachers to a variety of techniques, and by modeling those of which we approve, we help them understand the wide range of things they can do in their classes. We can see the results when teaching assistants in English apply to teach in the Composition Program. There the duties are quite different: the TAs in composition have full responsibility for the sections to which they are assigned. They are expected to use the full range of teaching techniques, from brief lectures, to recitation, to small group sessions, to individual conferences. In addition to those classroom methods, we also introduce teachers to the various ways to assign writing, intervene in and support students' writing processes, and evaluate student writing as it is being planned, in draft, and in final form.

Teaching Problem-Solving Skills

Bert E. Fristedt

The term "problems," as I will discuss it, does not refer to exercises illustrating some concept or theory which has been introduced in the classroom through lectures or readings. Rather, it refers to exercises which allow students to understand theoretical concepts by observing similarities and differences among widely divergent problems. An instructor using problems as a teaching device has the opportunity not only to teach a body of theoretical knowledge but also to teach students how to make use of it.

There are a number of advantages to this approach to problem solving. First, problems, if chosen with care, serve as natural motivation for exploring various concepts and theories. Second, problems help reinforce learning of major concepts through repeated applications. Third, problems help students appreciate the power of theory and the purpose of general concepts.

One might ask if there are major disadvantages which follow from a use of problems as a learning device. My feeling is there are not, although there are some pitfalls to be avoided. For instance, a particular problem will necessarily be more difficult when it appears "naturally" than when it appears as an illustration of some general concept introduced in text or lecture. Generally, a temptation for the instructor is to hint to the student how the problem should be solved. However, the benefits mentioned above may be lost if the instructor intervenes in this way. Although hints play a constructive role in teaching problem-solving, it is usually better to simply introduce easier problems which allow students to develop the necessary theoretical understanding more gradually.

In addition, some students may be slow to appreciate all that they have achieved. While the instructor may recognize that an idea developed in solving one problem is applicable to many others, students may not realize the connections unless the instructor points them out. An instructor can introduce theory and concepts into the class as the situation allows and remind students that they have already discovered the principles in their own problem solving. In my classes, I introduce many problems with particular substantive goals in mind and, once the students have worked through them, I make sure the salient points are recognized.

What about teaching problem-solving itself as opposed to using it as a vehicle for new concepts, methodology and theory? I believe that one learns how to solve problems by solving problems. Nonetheless, there are many useful techniques of problem-solving that good problem-solvers know, at least implicitly, and that poor problem-solvers do not. Lecturing on problem-solving techniques in the abstract can be sterile and non-productive, but the failure to make the techniques explicit when they occur naturally is to miss the chance to help students' problem-solving abilities grow.

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How to Get Started

The suggested method which follows is based on my experience teaching a problem-solving course to 19 Minneapolis and St. Paul secondary mathematics teachers during an intensive three-week program in June, 1985 (10:00 a.m. to 1:30 p.m. Monday through Friday).

1. *Assess the ability of your student audience.* One of the advantages I had in teaching this course was that the audience was comprised of students who by and large were familiar with the discipline. Because they were already acquainted with the rudimentary procedures, there was little difficulty in dealing with complex problems.

   A similar approach may be used with less advanced students, but some care should be taken to provide problems which are accessible to them. For instance, an instructor might want to use problems which address one particular concept or theoretical principle rather than problems which incorporate several abstract principles simultaneously.

2. *Prepare problems which allow students to draw theoretical connections.* Preparing the problems to be used in the course is probably the most important task involved in this problem-solving approach. First, as mentioned, the problems must be at a level commensurate with the skills of the students. They should be designed to "stretch" the students' capacities without causing them too much anguish or frustration. Second, the instructor must make a conscious effort to design sets of problems which have interconnections that the students are capable of discovering, at least partly, on their own. Finally, it is helpful to provide a large set of problems even if every student does not complete all of them. This challenges the more advanced students and often circumvents the tendency for them to "explain" the problems before other students have worked through them.

3. *Resist the temptation to jump in too quickly to explain to students how a problem ought to be solved.* In order for the methods to be effective, students must be encouraged to "grapple" with the problems and recognize the theoretical underpinnings without undue intervention on the part of the instructor. The overriding principle behind the approach described here is that students will better understand the materials if they draw connections themselves. An instructor who fails to resist the temptation to "give students the answers" deprives them of the benefits of the discovery.

4. *Use class discussions whenever possible as a springboard for your own comments.* With this approach it is useful, as I will illustrate in the next section, to stop and summarize students' comments about the problems either as a means of clarification or as an illustration of the importance of a concept. In phrasing your comments, try to make use

of the class discussion by bringing in useful comments made by students, pointing out misconceptions that have been prevalent, etc. The more effective you are in relating your own comments to the class discussion, the easier it will be for the students to understand what you are trying to say.

Using student discussion as a basis for your own remarks also gives the students a greater appreciation for comments made by their peers. Typically students are accustomed to viewing the instructor as the only useful commentator in the classroom. It takes extra effort on the part of the instructor to convince students that their peers' comments are worth noting.

5. *Be flexible.* Because the students themselves will be generating topics for discussion and introducing, albeit sometimes inadvertently, theoretical principles you wish to cover, you must be flexible enough to make use of appropriate openings which allow you to make important points. Certainly many instructors find it easier to come to class on a given day with a set of notes listing the concepts and facts to be introduced. An instructor who encourages students to set the pace of progress and determine, through their questions and comments, when a given concept should be introduced will find the effort well rewarded.

Sample Applications

The preceding principles may become somewhat clearer in the following discussion of how I applied them during the first class session. I began the course by handing out two or three pages of problems, giving an introductory lecture on what I had in mind, and describing some mathematical games we would encounter in the class. I mentioned in the lecture my own daily attempts to solve new problems and the experience of discarding my ideas at times in response to wise comments made by fellow faculty or students.

In the latter half of the period, students were broken down into small groups to work on the problems I had handed out earlier. After a half hour of group work, I called the class together and asked for volunteers to discuss the problems. The first problem we examined generated considerable class discussion since students had various approaches to its solution. Although I had strong opinions about the relative merits of the proposed methods, I did not evaluate them right away. Only after the discussion slowed down did I present what I considered a sound resolution of the matter, and then I was careful to rely as much as possible on what had already been brought out in the discussion. Finally, I pointed out new problems which could be approached in similar ways before asking for volunteers to address another problem.

". . . problems, if chosen with care, serve as natural motivation for exploring various concepts and theories."

"I believe that one learns how to solve problems by solving problems. Nonetheless, there are many useful techniques of problem-solving that good problem-solvers know, at least implicitly, and that poor problem-solvers do not."

The next item brought up for class discussion was the game of "nim." One student in the class had reached a correct conclusion concerning a particularly simple version of the game but had considerable difficulty articulating his approach. I took the liberty of rephrasing his comments to make sure the entire class was in tune with the discussion. I also tried to solicit questions from those who might be having trouble following what at times became a rather rambling discussion. (The discussion rambled because students had considered various special versions of the game.) Eventually, when I decided that no one had further constructive comments about the game, I summarized, using precise statements of theorems, what I believed had been proved in the course of the discussion. Then I stated, again using the board, what I believed at least some people in the class were conjecturing.

I followed this procedure every class day when, usually, many problems were discussed. I kept adding to the set of problems from which students could choose to work. To some extent, the students' interests determined the direction of the course. I approached the course with a flexible attitude. Since the sessions in which various class members described their solutions or progress seemed to work well from the beginning, I never assigned particular problems or gave particular assignments.

In addition to the set of problems considered in class, student groups were also assigned a joint project, the specific nature of which was determined by each individual group. Students worked on a variety of projects. Four chose to do a report entitled "Going to the Workforce," four more worked on a compendium of the problems and solutions treated in the course, and those remaining worked on projects relating to teaching problem-solving.

Challenges and How to Deal With Them

There were three trouble spots in the course. Since class members were presenting complex information about the solutions to problems, the presentations were sometimes difficult to follow. At times I felt compelled to interrupt in order to make sure the class was following. I tried to word my re-explanations in a way that did not reflect negatively on the person doing the explaining or on the questioner if my comments came in response to a query.

A second trouble spot was of my own making. At one point I thought a student's solution was close to another topic that had not yet appeared in the course. So I decided that this was my opportunity. As I was verbally making the connections at the chalkboard, it developed that the connection was more complicated and less striking than I had anticipated. I handled the situation by admitting my error

and then giving a separate short introduction to the topic I had wanted to present. I resisted the temptation to explain how my error had arisen.

The third problem was that some class members were much more proficient than others at doing problems. I essentially did nothing about this although the best problem solvers did help, individually and on their own, by not volunteering to give solutions to the easier problems. The reasons I did nothing are the following: most students made some classroom contributions; every student seemed to be following most of what went on in class; and my feeling was that so many things were going so well that I did not want to tinker.

The Rewards

The greatest reward from using this method is in seeing the students respond. Since my class consisted of people who were already in the workplace, I did not feel I had to set up a formal structure to help me decide on the most accurate grades for the students, and it developed that no such structure was needed for motivation. The rewards for the class members seemed to consist in self-satisfacion and constructive interaction. I think the class members also acquired many problem-posing and problem-solving skills that are transferable to the classrooms in which they teach. However, this achievement may be clearer to me than it is to them.

Organizing Community Studies

Peggy Sand

The term 'community studies' refers to a wide range of activities undertaken by faculty and students for a community. Usually in a community studies project, students do research and produce, under faculty supervision, a tangible product which has been requested by a community. The "community" might be a neighborhood group, a citizens' organization, an elected town board, a local unit of government, or a public service agency. Broad-based citizen support (including nominal funding) is usually desired. Community-based projects can be used as case studies in a class, as special research projects through directed studies or field research registration, or as topics for senior projects or papers.

The objectives of one such community studies program at the University of Minnesota include:

1. To provide opportunities for students to enrich their education by applying their academic, problem-solving, and human relations skills to real projects;

2. To provide opportunities for interdisciplinary projects among faculty and students of many departments;

3. To serve Minnesota communities seeking the kind of assistance students can provide under faculty guidance.

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How to Get Started

There are several steps in establishing a community studies program:

1. *Determine the academic context.* To receive department support for community study projects and to get students and faculty to spend the extra time they take, first determine how community studies relate to degree requirements and existing courses. The timing and nature of student and faculty involvement can vary according to the overall academic program. Are community-based projects best used as case studies within existing classes? Do community studies work better in more independent student projects such as senior projects and directed studies? What kinds of projects and products are acceptable? What is a reasonable student load for faculty working with independent projects? Should there be coordination through a seminar?

   Before initiating a specific project, explore your motives and determine your educational objectives. Is the purpose of using the community-based project to teach content? Is the purpose to teach problem-solving methods?

   Upon finding the course or curriculum area for potential projects, the desired timing and duration of projects should be identified. Most projects should be

planned around the academic calendar. They or their phases should begin or end with each quarter or semester. Shorter projects within regular classes can be scheduled for three- to six-week blocks. One to three months is needed to set up most projects.

2. *Initiate relations with the community.* Ideally, the community should come to you asking for help. Their request increases the chance they will be committed to project funding, involvement, and implementation. Do not do an uninvited project in a community. A formal written request with letters of support from other groups is best.

   The faculty or a University representative should meet in person with community representatives to evaluate the community's commitment to the project and to clarify project objectives. Through both a meeting and written confirmation, the following issues should be addressed: What are the community's needs and objectives? Do they want any particular product such as a workshop, presentation, report, maps, newspaper supplement, slide show, survey? What groups support the project? How do they relate to other local groups and decision makers? Can they fund project expenses, arrange local meetings and publicity, and provide resource people? Would the project be better if done by professional consultants?

3. *Select the projects.* After the community has been screened and the project scope loosely described, the faculty or department should decide whether this is an acceptable project.

4. *Match students to the projects.* The nature of the project should suit the numbers and skills of students likely to be in the class or interested in doing the project. What do the students expect from the class or community studies project? What skills do they have in dealing with the content of the project, in group process, in communication, and in presenting materials to the public? Do you know the students or do they come with recommendations from other faculty? Do they have time to commit to the project? What motivates them?

   If skills of students are relatively equal, the faculty can randomly assign students to project tasks. When time permits, allow them some choice in project assignments. While student participation in these decisions is not essential, it is likely to increase motivation.

5. *Determine project methodology.* For projects of short duration (fewer than five weeks), with very large groups or with inexperienced students, the faculty should take the lead in organizing the project. Typically, the faculty hands out a statement which describes the scope of the project, the objectives, the methodology to be used and/or a set of expectations and deadlines. In longer projects and in situations where faculty

or consultants can advise, the students may be asked to draft a project proposal subject to faculty and community approval. In projects lasting one quarter, students should be given two weeks to do the proposal.

In a student project proposal and in faculty problem statements for more complex projects or for inexperienced students, a step-by-step process to achieve the project results should be developed. We often chart an outline of the six to twenty steps proposed. Faculty should anticipate the need for coaching some students in this area and encouraging several drafts of the project proposal.

"Community projects are by nature complex, bringing in many irrelevant details and complex political situations."

The timing and role of interaction with the community or the citizen participation should be planned. This should be based on discussions with community leaders who must completely support techniques to be used. The project proposal or an accompanying outline should state the purpose of citizen participation in this project. Generally, students should anticipate the need for *at least* three to six visits to the community for data gathering at key decision-making or project review points.

6. *Require a project agreement.* Students should understand that once there has been local publicity about a project or multiple meetings with community representatives, local expectations are high for some kind of tangible results. Not only do the people want the results but local organizers' credibility may also be on the line. Conversely, the students are counting on the community for reimbursement of project expenses and for genuine interest in the results. Students' registration for credit (which makes them responsible to faculty) helps reinforce their commitment.

   The faculty and community representatives should both accept and approve the project proposal. Often a board of directors or elected body passes a motion supporting the student project. Shorter projects organized more closely by faculty and agency personnel may get by on a verbal agreement. But, for most students' projects, a written project agreement is advisable.

7. *Use classroom resources.* These community-based projects are not usually internships with in-field project supervisors. Therefore, there is greater need for classroom and faculty support of the student effort. Classroom discussion or regular weekly or bimonthly adult-guided seminars of students doing comparable community projects are important. Group discussions of ten to fifteen students are ideal as an opportunity for students

to regularly share their concerns, problems, accomplishments and insights. Often what has worked well for a student in one setting is useful to another. In-class group discussions permit faculty to facilitate good working relationships in interdisciplinary teams and provide information and assistance in how to work effectively in groups.

8. *Guide community interaction.* Encourage good record-keeping and communication and urge students to keep a journal. Require students to make regular written or verbal reports after each community interaction. Ask students to obtain and turn in to the faculty copies of any newspaper articles about the project and any formal correspondence. Encourage students to prepare and attach a letter of transmittal with all materials left with the community. This can become increasingly important after students have left the community and people ask "Who did this? Was it approved? Is it the final version?"

   Students or faculty will determine the approximate times needed for community input or project review, but it is the community that should be responsible for scheduling, setting up, and publicizing them. Students are often surprised that arrangements for any kinds of meetings usually need to be made three to five weeks in advance to assure reasonable publicity. For major presentations, the community should be encouraged to solicit involvement of all local groups. Faculty should anticipate periodically attending student meetings with the community.

9. *Evaluate project results.* At each phase of the project, students should present their findings or turn in a report to the faculty. At the completion of each phase, the overall proposed process should be reevaluated and, if necessary, changed to meet new findings. Such changes should require faculty approval and, if major, an okay from the community.

   By grading the initial project proposals and interim project reviews, faculty can reinforce their value. Group cooperation can be reinforced by giving some portion of a grade for it. Interim project reviews can help students keep on schedule during long projects. But, particularly in a complex, multi-phase project, care is needed so that comments and grades work as constructive criticism, not demoralizing judgments or disincentives.

   Contact community representatives within about one month of project completion to confirm that they received all the project results and any materials borrowed from them. If possible, a year later in each community, contact a cross section of community representatives to document the project's effectiveness and any action that has resulted from it.

Sample Applications

Among the undergraduate community study projects which took place in 1984 and 1985 are several which illustrate a variety of approaches. 1) The Resource and Community Development Seminar involved faculty in six departments guiding a team of eleven students in a study of the recreation potential of an abandoned iron mining area. The project began with a two-day community visit including a town meeting, and culminated six months later with the production of a 129-page report. 2) An individual housing major worked with a local commission to determine use for a new senior citizen center. The student surveyed potential users and helped divergent groups work together to implement their ideas. 3) Landscape architecture students have worked with communities in their senior thesis projects. One quarter each student prepared a two-credit proposal and during the subsequent quarter carried out a six-credit project. Landscape architecture students in basic design classes were involved in three-week, well-organized community design projects. 4) Through the Community Studies Seminar, a faculty team guided twenty-seven students from four departments working with eleven communities. Several multidisciplinary teams with students registering in their own departments were organized through this weekly seminar.

Challenges and How to Deal With Them

Finding a project suitable for use within a course which has its own educational objectives can be difficult. Community projects are by nature complex, bringing in many irrelevant details and complex political situations. There are risks that students may be dragged into political controversy. The project may be a pet idea of a few and disliked or of no interest to others and so the financial and other support needed from the community may fall apart after the project is well underway.

To avoid these risks, experienced faculty need to be involved in setting up projects. Use only projects requested by a broad constituency of the community and have project agreements signed. Allow extra time and faculty support to help students sort through complexities.

Finding students with appropriate skills can also be a problem. Generally only students with some background related to the project should do community studies. Once students are known, there should be opportunity to adapt the project to their interests and abilities. If students have a major difficulty in a project, plan some alternatives which save face for everyone. Allow the student to revise the project so it still meets educational and community objectives. Allow teams to regroup after an initial phase of a project.

Communication breakdowns can easily occur given the multiplicity of people (and "bosses"), the distance, the fact that most community people are volunteers and most

students inexperienced and so forth. Objectives may change as more is known about the project. Occasionally a community may become impatient for results when students are being encouraged by their faculty to do project documentation and analysis first.

To avoid these problems, carefully set up the project, instituting clear communication channels among students, faculty, and community. Faculty should lead class discussion about community interactions to help interpret communications. Faculty should step in quickly and meet with the community if major communication problems develop.

Keeping on schedule will be a problem unless the project is carefully scheduled either by the faculty or with thorough faculty review. Unforeseen circumstances, including bad weather, can prevent key community presentations. Some students will do other "easier" class work before doing "extra" projects. Others have problems keeping motivated during a long project.

The distance to some communities from campus is often cited as a potential problem. For well-organized projects in which students have a choice of location, communities fewer than three hours away generally present no problems. For large teams or classes, where scheduling any meeting outside class is difficult, distance can be an added problem.

Even though commitment and motivation are high, the number of incompletes at the end of a term can be higher than average, too. With community studies, students have a great deal of pride in what they will give to a community, and at times they refuse to complete it until it is done right, even when there is a grade penalty. At times communities will schedule final presentations weeks after the class ends and students want to work for that due date. Faculty may want to grade a project on whatever is complete at the due date but then ask the student for the final results for the record.

Rarely do students fail to complete the project once they are substantially into it. In most circumstances a student who persistently fails to meet deadlines, offers repeated excuses, or has inadequate submissions throughout a quarter should be terminated immediately from a community project, since it hurts everyone's credibility. The faculty should inform the community promptly rather than let performance problems drag on.

Finally, quality control may be a con Usually these are student pro nd not faculty research projects ost are very impressive by community standards and adequate or better by classroom standards. But they do go out to the public with faculty and department names on them. Faculty have to decide what they will do if a product is received the last week of the quarter and it reads or looks rather awkward.

The Rewards

For the student, the most obvious benefit is the practical experience in applying skills and knowledge. This is a learning experience in itself and students have also directly gained by listing the project on their resumes. Working for a receptive community is very motivating — the student knows the people are depending on him/her and this responsibility frequently leads to higher levels of performance. The deadlines are very real to the students; there are presentations to schedule, community meetings to publicize and newspaper publishing deadlines to meet.

"For the student, the most obvious benefit is the practical experience in applying skills and knowledge."

Communities are usually impressed with the quality of student work and openly show their gratitude. This positive response builds confidence in the student. The students can develop abilities to work with others, make valuable professional contacts, and learn new approaches to the projects from each other. The students learn firsthand about community values, issues, political processes, and local economics.

Both faculty and students can use the community study situation to try new problem-solving methods. Faculty may find that the community study project provides an opportunity for applied research on a subject of special interest to them. Decision making and practice in using specific techniques lead to skills transferable to other life and professional settings. The very procedure of faculty and students together designing the problem-solving process brings with it a mentor-apprentice rapport.

While working with the community, the faculty can discover emerging issues and build a rapport with community leaders which may lead to future faculty research projects. In many cases the community study project may be the first direct contact between the community and members of a particular discipline. How many people in a small town or neighborhood really know what a geographer does? Community study projects offer an opportunity for very positive public relations for the departments, disciplines, and professions.

Where to Get Help

The Center for Community Studies is located at 201 North Hall, St. Paul Campus, 373-0272. It is available to faculty who want help finding communities, contacting local agencies, and structuring projects, to students looking for projects for directed studies or senior papers, and to communities seeking student/faculty help. A resource center has been developed with books, etc. about community participation techniques, community organizing, needs assessment techniques, town/park planning and design, group process and related issues.

Some University of Minnesota departments and faculty with community studies experience are agriculture and applied economics, architecture, forest resources, housing, landscape architecture, recreation, parks and leisure studies, and urban studies.

Other University of Minnesota units offering support services include: Agricultural Extension Service; Cooperative Learning Project; Office of Special Learning Opportunity; and Center for Urban and Regional Affairs.

Teaching Cognitive Skills to Underprepared Students

Diane Chambers

As instructors, most of us have heard (or uttered) the complaint that students don't (or can't) think. Yet in our teaching we are often inclined either to assume that students know how to perform certain mental operations or to ignore their analytical shortcomings by substituting the mere memorization of course materials for their real analysis. Even when instructors sense that students are not analyzing well (or at all), they may assume that teaching thinking skills is an impossible task or at least a process too time-consuming to be undertaken in the average college classroom.

In recent years, the Supportive Services Program (SSP), which serves approximately 25 percent of the freshman population at the University of Minnesota-Duluth, has become increasingly concerned that academic problems of underprepared students go beyond deficiencies in writing, reading, and math and are symptomatic of more basic problems in thinking and problem-solving processes.

To address these problems, SSP has introduced into its classes the Feuerstein Instrumental Enrichment (FIE), an intervention strategy designed to assist underprepared students in improving problem-solving skills. Although in our case the method has been introduced into courses especially designed to improve student cognitive skills, we believe that the same principles applied in any classroom setting will produce favorable results.

How to Get Started

The Feuerstein Instrumental Enrichment program focuses on the development of both cognitive skills and learning motivation. Through a variety of exercises, students are required to use higher mental processes in sequences which involve various levels of complexity and novelty. As students become increasingly competent in finding solutions to difficult problems, they become more confident in approaching new problems.

Instructors in the Supportive Services Program have received considerable training in the use of Feuerstein techniques and have found the approach described in this chapter highly successful. Although use of the specific Feuerstein exercises requires some training, faculty members who are concerned that their students — at whatever level of academic achievement — should develop more effective cognitive skills may find that the suggestions below can be applied in a variety of courses without additional instructor training.

1 *Identify the problem.* Thinking is a complex and somewhat intangible process. In order for us to be able to teach students how to think, we instructors must first make some

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"Teaching cognitive thinking in addition to the regular course content may require a new balance of process and content."

decisions about the kind of thinking students must do in order to be successful in an academic setting. In some courses we can emphasize teaching students how to think hypothetically; in other courses, instructors might be more concerned with teaching students how to make value judgments. In either case, the more an instructor knows about the kind of thinking students are expected to do, the better he or she will be at teaching them how to do it.

2. *Describe the cognitive stages.* For most of us the process of thinking analytically is almost automatic. We may even be unaware of the steps we go through in doing it. For some students, however, an assignment such as "compare the British and American systems of government" may be very confusing. Many will simply list the characteristics of each of the systems without taking the next step of actually making the comparison. An instructor can help students by spending some class time discussing the process necessary to completing the assigned tasks. In the SSP courses, we have agreed to introduce the following elements as a strategy for analytical thinking:
    a. Define the objectives of the task.
    b. Note the information given in the problem itself.
    c. Plan a strategy that will allow you to address the problem.
    d. Determine the rules which would operate to solve the problem.
    e. Check your work both when you are working on the problem and after the task is completed.

There are a number of sources which may help you decide how to present the process of analytical thinking to your students. See, for instance, Barry Anderson (1980), Edward deBono (1976), and Wilbert McKeachie, ed. (1980).

3. *Establish a "thinking vocabulary" for the class.* It may be useful to establish a vocabulary list with which students are expected to be familiar by the end of the course. To repeat such words as "comparison" and "hypothesis" in lectures and class discussions may foster analytical thinking because these encourage students to stay with their materials.

4. *Provide models of the processes you want students to emulate.* Since they often learn best by example, it is good to spend some class time on exercises designed to encourage the types of analytical thinking students are expected to undertake on their own. For example, in my class students were expected to understand the process of decision-making. I outlined for them the processes I used in deciding whether or not to buy a MacIntosh microcomputer. The class discussed the steps I had taken in making the decision without knowing my final decision. After adding some

considerations, they made a collective decision which they then compared with mine. Having gone through the process in class, students were better prepared to complete a similar decision-making assignment individually.

5. *Provide reinforcement through feedback.* Students may not always see how strategies used in one situation are useful in other, similar situations. One of my students, for instance, was given a process for solving word problems in her elementary algebra class. But because the instructor made reference to the process in connection with only one problem and never explained its relevance for problems of this type, the student never used it again. When I presented the same process in my class, the student suddenly understood the utility of the process for solving word problems in general.

Sample Applications

At the University of Minnesota-Duluth, a number of programs designed to assist a wide range of individuals traditionally disadvantaged in higher education have been merged into the Supportive Services Program. Courses offered include Reading Skills, Study Skills, and a course specifically focused on cognitive thinking. When the decision was made to introduce the Feuerstein method into SSP classes, instructors in the program received training in the Feuerstein techniques. The training was followed by a series of staff meetings which focused on developing teaching strategies which would be consistent across classes.

In the first such meeting, an all-day session, the staff drew up preliminary drafts listing thinking principles in which we collectively believed and common "thinking vocabulary" terms that we would agree to reinforce in our classes. Regarding thinking principles, for instance, we were agreed that, among other things:

- effective automatic thinking processes should replace ineffective automatic thinking processes;
- awareness of how we think, what we value, and how we solve problems can lead us to make more effective choices;
- class time should be provided for thinking and reflection;
- hypothetical thinking can be used to predict the consequences of our actions (to determine the result of an act before we do it).

In all, the staff developed a list of 43 learning principles around which courses were formed during the 1984-85 academic year.

The same procedure was used to devise a final vocabulary list of words with which we thought students should be familiar. The final thinking vocabulary list includes 59 words and phrases which were to be reinforced from course to course. Academic units on campus have since worked to coordinate their content vocabulary and have discussed how to help students become more familiar with the terminology of their disciplines.

In the individual SSP courses, instructors were careful to reinforce the students' use of both the thinking principles and the thinking vocabulary we had agreed upon. We provided guided practice in the kinds of analytical exercises students might encounter in content courses at the University. We also provided models representing the kind of work which students are expected to achieve. For instance, one instructor placed the best term papers from her students in a file for other students to examine; another wrote sample book reviews to give students an idea of what instructors might expect.

In each class, instructors cited evidence of behavioral changes in students, including:

- improved communication skills (greater willingness of students to participate in oral discussion; increased relevance of their questions and answers; more active listening; and students' improved ability to defend opinions on the basis of logical evidence);
- overcoming passivity as demonstrated by students' initiating ideas, showing curiosity, volunteering for additional tasks, helping others, and being willing to take risks without fear of failure;
- increased ability to define problems systematically and plan problem-solving strategies without the impulsiveness of trial and error tactics;
- developed ability to transfer learned concepts and problem-solving strategies to academic studies and life situations as a result of seeing and projecting relationships, and gaining insight into thought processes;
- acceptance of responsibility for independently gathering and organizing information, doing more precise work, reading and using directions, correcting errors, and making decisions based on logical evidence.

Challenges and How to Deal With Them

Teaching cognitive skills to students, particularly to underprepared students, can be a difficult process. Most instructors are used to covering considerable course material in a 10-week period. Teaching cognitive thinking in addition to the regular course content may require a new balance of process and content. To dump information on students, particularly if they are not equipped to deal with it, generally results in little more than the memorization

of isolated facts. While instructors may have to make some decisions about what substantive material is most important students are likely to leave the class with an analytical framework on which to "hang" new information.

Students may also suffer some impatience if they are asked to slow down to examine the processes they use to derive their answers. Most students are conditioned into the "right answer syndrome" and may become openly hostile when an instructor indicates that some problems allow for more than one solution strategy.

In addition, teaching cognitive thinking skills requires considerable planning by the instructor. Instructors may find it takes time to develop models to illustrate the kind of thinking processes they would like students to follow. And we must determine the sequence in which to introduce facts and concepts.

The Rewards

Underprepared students can be a lackluster, passive, unmotivated group of people through no fault of their own. Often they do not see a purpose behind their class work. But when we focus their attention on thinking skills, we see many of these students transformed into participants who are active and enthusiastic about their academic activities. Instructors in our program noted a strong increase in the students' motivation, and overall improvement in their self-concepts.

Students previously passive began to discuss, argue and produce some wonderful papers. They were able to respond to others when asked questions about what they were doing, and they learned to defend their answers when asked why they had come to a particular conclusion. The main reward for an instructor is in seeing such changes take place.

Another reward is the excitement of teaching students to learn. It is much more fun to teach students who are actively involved than to wait passively for something to happen.

Underprepared students are often at a disadvantage because they lack the generative thinking skills necessary for doing well academically. The approach outlined here illustrates one attempt at preparing these students to perform more successfully at the university level.

"... when we focus their attention on thinking skills, we see many of these students transformed into participants who are active and enthusiastic about their academic activities."

Personal Computers in Education

Alan Wassyng, Karl Smith, and Sam Sharp

Not too many years ago educators became entranced by the thought of harnessing the power of computers to take over the teaching process. For quite some time the computer was touted as *the* solution to the tremendous problems in technical education. However, it became apparent that the much heralded arrival of computers and, in particular, Computer Aided Instruction, did not have the effect everyone had hoped for. It is only in very recent years that computers have started to play a significant role in education. This turn-around has come about mainly through the proliferation of low cost, capable, personal computers. Together with, or perhaps because of this proliferation, many educators have come to realize that computers should be used for what they are — extremely versatile *tools*.

"Computers should be used for what they are — extremely useful tools."

This chapter deals with the effective use of personal computers in the educational process. We do not address computer drill and practice as popularized in traditional Computer Aided Instruction, but rather one of reference is the kind of courses in which problem solving is a principal component. Our own experience is with engineering courses, but we feel that our ideas are pertinent to social, natural and physical science courses, and many of the more technical business courses. Although we cannot make any claims about the application of our techniques and ideas to other areas, we think we have discovered principles that transcend their boundaries. What we offer is our experience in using personal computers for engineering education over the past five years. We have been heavily involved in this process, and share the excitement engendered by actively involving students in the learning process through the use of personal computers.

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Sample Applications

We see two kinds of computer use in education: 1) The use of the computer as an *applications tool* to solve problems in whatever discipline is under study; and 2) The use of the computer as an *educational tool* used to teach students something about a technique, the behavior of a system or perhaps the mechanics of an algorithm. These uses are not mutually exclusive.

1. *The computer as an applications tool.* Our experience shows that students learn best when *actively involved* in the learning process. The computer can and should be used to promote such involvement. Generic computer software such as word processors, spreadsheets, database managers, and statistical and graphics programs are invaluable in this regard. In particular, the use of a spreadsheet program such as Lotus Corporation's 1-2-3 can be used to enable the student to try many different values for crucial dimensions in a

particular study. In situations where the student has no expertise in the use of the spreadsheet program, the instructor can prepare a template. While a template includes all the necessary formulae, it is also possible for the user to change some values in the worksheet. In this way the student can determine the effect of such changes without becoming deeply embroiled in the setting up of the spreadsheet itself. Of course, the student can still examine all of the pertinent numbers and formulae.

A few additional hours of instruction on spreadsheet fundamentals will permit the students to be more deeply involved in creating the spreadsheet formulae.

For example, we are currently planning an engineering-oriented modeling course. As this course is to be given early in a student's career, we cannot assume much computer programming expertise or any significant mathematical sophistication on the part of our students. The emphasis during the course will be on the formulation of the model and its relation to the physical system it has been designed to represent. In order to achieve our goals the students must be able to solve the mathematical problems that arise in such endeavors. We intend to use a spreadsheet program (probably Lotus 1-2-3®) in conjunction with very basic numerical methods. We are confident that we can adequately introduce students to 1-2-3 in two to three hours. We will then introduce appropriate numerical techniques as they are required. Many spreadsheet programs can also generate graphics (for example x/y graphs), which greatly enhance the students' understanding and involvement.

Specific applications packages, such as simple beam analyses, may be used to enable the students to solve the number of problems sufficient to build experience that would otherwise take too long to acquire. In this case, the instructor has to balance carefully the time at her/his disposal to explain methods of solution and the understandable inclination of the student to use such a package without mastering the concepts involved.

On another level, word processing can be an extremely effective way in which to involve the students in the learning process (Nathan, 1985). Our experience in getting students to use a word processor to write up their reports has had a remarkable side effect. They put considerably more effort into their reports. Students clearly feel some obligation to match the content of their report with its now improved appearance. What this means in practice is that they spend more time polishing their work. This often results in a deeper commitment to understand what they are writing about.

2. *The computer as an educational tool.* Students are currently taught to use computers as a tool they will eventually employ to help solve problems in their fields of interest. It is this capability that sets the computer apart from other teaching aids. Using the computer simply to automate what teachers and textbooks have traditionally provided for

students is not adequate. Even if the computer is able to react in a reasonable manner to students' input, we do not think that present computer technology can present factual material as effectively as books and magazines can present it. And, although computers can be used to present material and test students' understanding of that material, they are not adequate substitutes for human teachers. One of the main reasons that computer aided instruction is considered an attractive alternative to traditional teaching is that students are able to proceed at their own pace. Quicker students are not bored and slower students are not left behind. However, this is not really a justification for using computers over human beings in the ideal case; if there were enough good teachers to work individually with students this argument would not hold. So, at best, the use of computers in this way is an attempt to overcome a "numbers" problem.

A more practical drawback to computer assisted instruction is that good teachers usually loath using teaching material prepared by somebody else. For good reason, they like to explain things in their own language, using a notation with which they are comfortable. This means that mass produced courseware *starts* at a disadvantage.

Students need to build experience through active participation in studying the behavior of a variety of systems (Arons, 1984; Hartley, 1985; Smith, Starfield and Macneal, 1985). It is all very well for them to learn the theory behind some phenomenon, but actual experience is often necessary before students really understand

We believe that we should use computers, books, video, handouts, overhead transparencies, chalkboard; each wherever it is appropriate. At the moment it seems that a well trained, motivated teacher has no peer in the presentation and discussion of ideas and concepts. The teacher should use the tools mentioned above to supplement the educational process. Books, magazines and notes can be used to impart information to students (usually in the teacher's absence). Video could be used this way or, like overhead transparencies, it could be used to impart information during formal lectures and discussions. The computer, however, is different. It has an advantage that none of the other media has: it can solve problems.

The personal computer can be used to develop special educational programs which permit students to develop this experience. Most of the instructional software we have developed is designed to use two screens simultaneously, one screen for color graphics and the other for text. This enables us to present complementary pictures and text without having to flip from one to the other and without losing the amount of information we would have to sacrifice if we were to use "windows" on the relatively small screens available on most personal computers.

Two examples, a water power system simulation and a critical path scheduling, will illustrate our use of the computer as an educational tool.

Example 1:
A Water Power System Simulation
A typical water power system consists of a water reservoir, two surge shafts and a shut-off valve downstream. We assume that the reservoir is kept at a constant level and that the shut-off valve is closed at a constant rate. The emphasis in this simulation is to examine the effects of the rate at which a student may close the shut-off valve.

Here students can observe for themselves that a rapidly closed valve will oscillate in the surge shafts. However, if they close the valve slowly, the water levels in the surge shafts approach their equilibrium levels in a rather sedate fashion. The fact that the students control the system enables them to experiment with the system just as if they were experimenting with the real physical system. The advantages, of course, are that many different cases can be tried and thus some insight acquired into the behavior of the system. The graphics in this example really spell the difference between success and failure.

Traditionally, the results of simulations like this have been tabulated: numbers depicting the levels of the water in the surge shafts, numbers for the velocities, numbers which have to be interpreted. In those cases where graphs are used, they are traditionally graphs of height versus time. These graphs still have to be interpreted. The real system behavior is best understood by watching the real system (even if it is just a graphic representation). This seems to be the only way to develop a "physical feel" for the behavior of the system. The graphs and numbers are important. In fact, in some cases, they may show trends that are not obvious from simple observation of the actual system, but these are sophistications. What has to be achieved first is familiarity with the system, an understanding of how it works, and what actually happens. It seems to us that this is what is lacking in most modern technical education. All too often students are taught about details and sophistications before they really *understand* the basics.

Example 2:
A Critical Path Scheduling Package
Teaching critical path scheduling presents two difficulties. The first is how to show students the power of the technique, and how and when to use it in practice. The second is how to give the students sufficient knowledge of the algorithm and an intuitive understanding of why it works. The package we have developed was designed to cope with both these aspects. It solves critical path scheduling problems and also can be used to demonstrate the algorithm.

Food For Thought
Suppose you are planning a dinner for two. Your menu consists of a very special soup and a baked chicken entree. The soup must be boiled for 35 minutes and you should allow 15 minutes to serve and consume it. The chicken dish requires a fair amount of preparation. You have to boil rice (for 30 minutes), lightly fry the chicken (for 15 minutes), and then put the rice and chicken in a baking dish in the oven for 15 minutes. It takes 5 minutes to prepare a sauce in the

frying pan and 15 minutes to boil peas. (You only have two pots and one frying pan besides the baking dish.) You have bought a good white wine; allow 5 minutes to uncork it (very carefully) and let it stand for 30 minutes before serving it. Allow 25 minutes to serve and demolish the entree and wine. How quickly can you prepare and consume the meal?

"Food for thought" is the problem we use to introduce students to critical path scheduling. This technique can be used to represent task interdependence and precedence in a project consisting of numerous activities. Apart from performing such analyses, our critical path program can be used to illustrate the actual algorithm employed; this sets it apart from other applications packages and represents another effective use of the computer as an *educational* tool.

Figures 1 and 2 show two distinct stages in the "stepping" option in the computer package. The stepping option actually lets the user examine the critical path algorithm, step by step. Figure 1 shows the situation after the first four activities have been laid out on a time scale starting from the beginning of the project. In Figure 2 we see that activity 'Wine breathes' then follows activity 'Open wine.' The student can thus follow the algorithm as each task is added to the display. During this phase all activities are scheduled to start just as soon as they can.

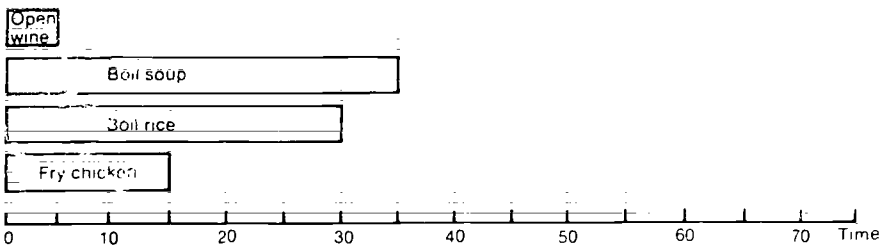

Figure 1

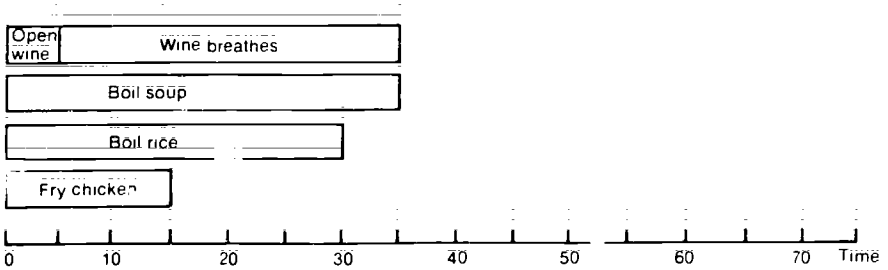

Figure 2

Figure 3 shows the paths when all the activities have been considered. At this stage it is easy for the *students* to identify the "critical path." This is the path(s) in which there is absolutely no slack time, that is, the path in which a delay in any activity will delay the completion of the entire project. In our example, the critical activities are: boil soup, eat soup, and eat entree. At this stage, however, the *computer* has not yet identified the critical path. In order to do so, all the activities must be shifted to start just as late as they can. This is shown in Figure 4. (Note that the activities are shifted one by one in the program. We have shown just the final result in the interests of saving space. Also, on the computer screen the display is colored to highlight salient points.)

Now the computer has all the information it requires. Finally, the student can discover how the tasks are interrelated by shifting any non-critical task. For example, if we try to [illegible] activity 'Prepare sauce' to start earlier than 35, we will have to shift activity

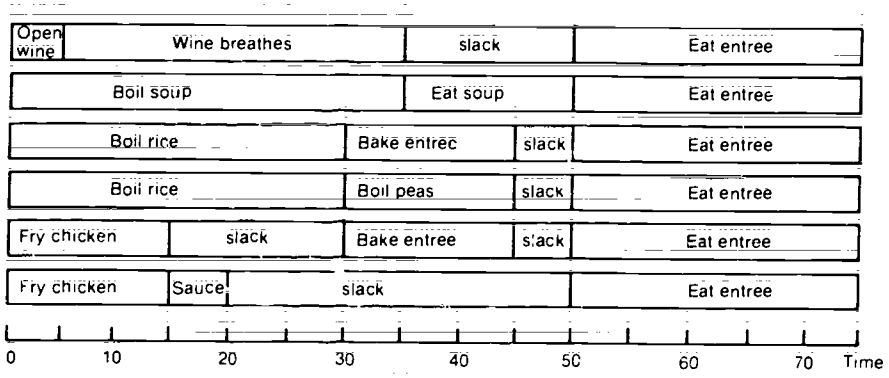

Figure 3

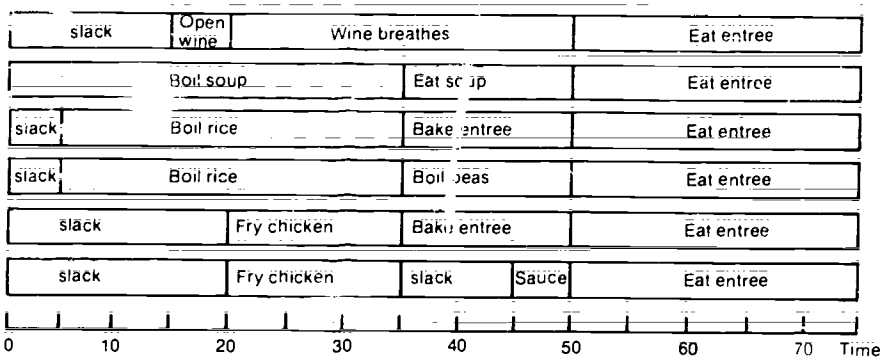

Figure 4

'fry chicken' first. This enables the student to develop a feel for the crucial notion of "float" (the slack time available in an activity).

The teaching aspect of the critical path program can be activated only if the problem being solved is "small." This means that a single program can be used as the students progress from the stage where learning the critical path method is important, to that where the emphasis is on the solution of practical problems. The students are thus familiar with the program by the time they have to concentrate on solving real problems and can devote their energies to the problems — not to learning how to use the computer package.

"Using personal computers in education is resource-intensive and the one resource it requires most of all is the dedicated teacher."

Additional detail as to how we communicate the need for the techniques and how the teaching software is used during the course is provided later in this chapter.

How to Get Started

At least one member of the instructional group should be reasonably familiar with personal computers. If there is no such member then your first priority is to create one! In many cases, we feel that students are far better prepared, emotionally as well as technically, for the introduction of computers in the teaching curriculum. So strongly did we feel on this matter that in early 1983 we ran two five-week courses to help familiarize our faculty with Pascal on personal computers. The courses were well attended, about 15 faculty per course.

Start small and choose your application area(s) carefully. The most successful approach is the evolutionary. If you cannot create your own software, or cannot get someone to create it for you, then try to determine how you can use existing programs in your field of interest. In fact, you would be wise to adopt this course of action *before* setting out to create your own software.

Estimate how many personal computers you will require for your particular class size. We have been quite satisfied using central clusters of personal computers, rather than requiring students to purchase a computer. A cluster of five personal computers can serve a class of 20 to 30 students if they have enough access. In the early stages, the arrangement of groups of two or three at a machine goes a long way in helping with two problems: i) fewer machines serve more students and ii) more importantly, the students assist and motivate each other during these crucial learning stages.

Spend some time in the early stages of the course to familiarize the students with both the hardware and the particular software they will be using. Effort expended at this time will significantly lower the frustration that students might suffer later in the course. If at least one cluster of personal computers is located in a room that can be used for "hands-on" demonstration

sessions, then the first couple of sessions should be performed in this manner.

As far as possible, provide the students with a written user's guide to both the hardware and software.

Using Instructional Computer Packages

As with any relatively new endeavor, there are many views and opinions on how computers can and should be used in the education process. We have just a few points that we think are important enough to be stated in the form of "rules." Note that these rules do not necessarily cover the cases in which students use computers to learn about computing.

1. *The computer should be used to promote active learning.* Instead of simply presenting information and testing the students' retention of that information, the computer should be used to involve the students in the active discovery of general principles. Usually such discoveries are made by the observation of similarities which occur in many different cases or systems. The computer provides us with the means of presenting students with a variety of systems in a short period of time. Principles which are discovered in this way hold much more meaning than those which are simply expounded during the course of a lecture.

2. *The computer packages should be tools which can be used to solve real problems in the particular field of interest.* These tools might also contain teaching aids, as in the critical path scheduling example above. In our experience this is a very effective way of actually getting students involved in the learning process.

3. *Graphics should be used (whenever it makes sense to do so) to illustrate the behavior of systems or to present an easily interpreted representation of a particular event.* In many cases the effective use of graphics enables the computer package to behave as another "language" to impart important information. Traditionally, the language used in such cases is mathematics, but very few students can readily read physical meaning into the equations they derive or study.

4. *As far as possible, the computer packages should be constructed/used in such a way that the emphasis can remain on the subject at hand, rather than on the mechanics of the computer implementation.* It is clear that some computer programs are more easy to use than are others. "Ease of use" in packages designed for teaching is of paramount importance. The most important attributes of such packages in this regard are that: i) it is obvious how to proceed at any stage in the program; ii) sufficient information is displayed on the screen(s) to avoid continual reference to another location (screen or printout) for essential information; iii) in spite of the previous point, each point be economically stated and arranged so that essential information is immediately obvious; iv) error messages, as helpful as possible, do not obliterate the information that was on the screen at the time the error occurred; and v) these

packages must recover gracefully from users' errors.

5. *The computer packages should not be viewed as something separate from the rest of the teaching process.* They should be an integral part of an educator's toolkit and should be regarded as support mechanisms which may help to introduce and reinforce ideas or simply act as tools in the solution of relevant problems. They should never be used in isolation, but should be combined with relevant lectures, assignments, and reading material.

We have been using instructional computer packages for about six years now in the Department of Civil and Mineral Engineering at the University of Minnesota. Since 1981 we have relied mainly on personal computers as the machines of our choice. Initially we used Apple II computers but now have migrated to the IBM PC. The response from students to the inclusion of instructional computer packages has been more than encouraging. They indicate that our extensive use of personal computers is a major reason for electing to take our courses. Also, students have been encouraged by the "friendliness" of these small computers and have been happy with their increased access to computers. We have noticed a distinct improvement in students' basic understanding of the course material, and a refreshing amount of innovation and creativity in the way they have tackled their assignments.

We have used these packages in two ways. The first and obvious way is simply to make the programs available to students so that they are able to use them in the solution of assigned problems. They are thus simply application tools. Some of the packages can also be used as educational tools. While this use means more preparation for instructors, it also increases their effectiveness (Smith, Wassyng and Starfield, 1983).

Initially, we present students with a problem which can be solved using the technique we are about to study. The problem itself is not very difficult and the students are not informed as to what technique is involved ("Food for Thought" is an example). They are divided into groups of two or three and asked to formulate and solve the problem during a 45-minute session. This session is run as a group active learning project. At the conclusion of this session, the groups are requested to present their solutions. They are then asked whether or not their methods could cope with slightly altered or complicated versions of the problem. In this way they get to understand the need for the technique we are about to introduce and gain a first-hand understanding of the difficulties involved. The technique itself could be introduced during a structured tutorial (the students are queried and prompted to discover the essential steps in the algorithm) in a typical lecture session, depending on the complexity of the technique and the background of the students. At the successful conclusion of that stage, textbooks and other reading material are recommended. This is an essential step to broaden the students' understanding of the subject. The computer

packages can be used during this introductory stage simply to demonstrate the approach.

A succession of assigned problems follows this initial problem. These can be relatively small, and we recommend that at least one of the problems be done manually. That same problem, and all of the others, should then be solved using the computer package(s). At this stage the computer package is used in either a teaching mode, or simply as a tool, depending on the students' requirement.

Finally at least one open-ended problem is assigned to the groups. The problems are open-ended in that there are numerous ways to formulate them and the solution is sensitive to the assumptions involved in the formulation. By having to pose some of the questions themselves, students develop skills at solving realistic problems and are motivated to achieve a more basic understanding of the behavior of the systems they are studying. At this stage, the computer packages are clearly used just as application tools in the solution process.

Challenges and How to Deal With Them

Although there are significant pitfalls in the use of personal computers in education, our experience is that the rewards far outweigh the difficulties. Also, with just a few exceptions, the problems in using personal computers in the teaching process are no different from those inherent in striving to achieve quality education independent of tools and techniques.

The following points highlight the major obstacles.

1. At this time not enough educators are familiar with personal computers or competent to use them in instruction (Turner, 1985).

2. Although the cost of hardware is decreasing, costs of both hardware and software are still significant.

3. Not enough quality instructional software is available.

4. Currently there is little institutional incentive or reward for faculty working in this area. Computer programs do not appear to count as learned publications, and they take much longer to create (Turner, 1985).

5. It is imperative that students do not come to rely on solutions provided by the programs without understanding how the solution was reached, and without checking the solution for reasonable behavior. (This has always been a widespread problem in the use of computers in practice as well as in education.)

Conclusion

Using personal computers in education is resource-intensive and the one resource it requires most of all is the dedicated teacher. We see no realistic way of getting a computer to cope adequately with the task of monitoring a student's progress or of tailoring additional help to a student's needs, not if we want to retain any thoughts of nurturing creativity and of creating a climate of healthy skepticism. And without creativity there is very little progress!

The computer should be recognized for what it is — an extremely versatile *tool*. It can supplement traditional educational processes, but it should not supplant them. The computer can and should revolutionize teaching, but it should do so by making it easier for students to experiment with many different situations. It should not be used to instruct the students; the students should become adept in instructing it and in harnessing its power for their own individual uses.

With the availability, relatively low cost, and effective graphics of modern personal computers, it is now possible to provide students with enough access to computers to make the computer an invaluable tool in education. We will be missing an outstanding opportunity if we do not do so. But inappropriate use of these machines could destroy most of the current good will and excitement that we enjoy today. We should not trivialize the teaching process, nor promise more than we can deliver. But we do feel that effective use of personal computers to involve students more in the learning process can greatly contribute to technical education.

Acknowledgements

We gratefully acknowledge the assistance of Anthony Scatfield, with whom we have spent many hours discussing these issues. We owe a lot to Charles Fairhurst, our head of department, and to Kenneth Reid, the director of the Mineral Resources Research Center, who have provided us with opportunity, encouragement and support. The computer programs described have been developed as part of a joint studies contract with IBM, and we would like to thank those at IBM who have been so supportive of our work.

Questions and Answers about Active Learning

Gloria Christopher

The authors of the preceding chapters have made mention of some of the many rewards associated with the use of active learning methods. However, you may still have questions and concerns about active learning. The following questions were those most frequently asked by participants in the Northwest Area Program workshops. The answers are derived largely from a year-long evaluation process consisting of six basic elements:

(1) surveys and interviews of project leaders associated with the program from 1983 to 1985;

(2) surveys of 691 students involved in active learning project classes;

(3) surveys of 62 faculty participants in Northwest Area Program workshops and seminars;

(4) on-site visits to active learning project classes;

(5) informal interviews with students and teaching assistants involved in active learning classes;

project leader final reports;

More specific information about the evaluation procedures is described at the end of this chapter.

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Question 1: How widespread is active learning at the University of Minnesota?
In a survey of Northwest Area Program workshop participants, respondents were asked to indicate how often they used specified activities in their classes. The following table shows the activities used by the 62 faculty reporting five months or more after attending a workshop:

The widespread use of active strategies which involve students in an activity or which require interaction with peers is impressive. Results indicate that active learning techniques are employed by a large number of faculty members in their classes (e.g. group projects were used "usually" or "often" by 84% of the faculty teaching a lower division class, and given high rating by 37%). More traditional teaching techniques such as lectures and reading and writing assignments, however, are still the most frequently used methods.

The use of active learning methods appears to increase with the level of the class. A breakdown by class level (lower division, upper division, and graduate) indicates that while group discussion is used in 100% of the graduate courses listed by respondents, only 26.3% of faculty "usually" incorporate discussion into lower division classes, and 10% "never" use it there. Similarly, over 85% of the instructors teaching graduate courses reported using writing assignments "often" or "usually"; 47% of the lower division faculty reported the same frequency of use.

While the number of respondents in this survey is too low and the audience too

Table 1	Lower Division		Upper Division		Graduate	
Teaching Strategies Used by Faculty	Used by	High rating	Used by	High rating	Used by	High rating
Reading Assignments	95%	63%	100%	79%	100%	100%
Group Discussion	90%	69%	90%	72%	100%	100%
Lectures	89%	53%	100%	66%	86%	57%
Mini Lectures	89%	42%	85%	41%	100%	72%
Individual Projects	84%	47%	86%	61%	100%	100%
Writing Assignments	84%	47%	93%	66%	100%	86%
Group Project	84%	37%	93%	62%	100%	85%
Tests	84%	26%	93%	56%	86%	57%
Quizzes	74%	32%	82%	26%	50%	33%
Student Presentations	68%	16%	96%	63%	100%	86%
Field Work	68%	11%	89%	48%	100%	57%
Lab Work	53%	26%	77%	31%	67%	17%
Case Studies	53%	10%	77%	27%	86%	71%
Research Participation	47%	21%	82%	39%	83%	33%
Role Playing	47%	0%	58%	15%	100%	57%
Computer Work	42%	5%	60%	20%	33%	0%

unrepresentative to be taken as a sample of the overall University community, the data indicate that faculty *are* using active teaching strategies as an alternative or supplement to traditional methods. However, this is much more the case at the graduate level than at the undergraduate level.

Question 2: Do active learning methods really make a difference in the classroom environment?

The description of an active learning classroom in the Introduction offers an impressive contrast to many college classrooms. On-site visits to active learning classes suggest the description is not atypical. Repeatedly, these visits indicated a different kind of learning environment.

On the most basic level, active learning promotes activity. If we accept the position that classes which encourage full student participation are preferable to those in which students are more passive, active learning by its very nature is a positive alternative to traditional teaching methods.

Students in the Northwest Area Project classes reported that active learning classes afforded them more opportunity to take part in experiments, individual and group research projects, oral reports, field trips, learning groups, role playing exercises, and class and group discussions than did other courses taken at the University. Indeed, over 50% of the students surveyed reported more or much more personal participation in their active learning classes.

In addition to changing the level of activity in the classroom, active learning changes the patterns of interaction among students and faculty. It helps to transform relations between faculty and students and among students themselves. Northwest Area Project leaders used such terms as "moderator," "orchestrator," or "mediator" to refer to their new classroom roles. As one instructor put it:

> I no longer feel as though I am the only person in the classroom contributing to the learning process. Now my students are assuming more responsibility. They are, with my guidance, teaching themselves and their peers. It makes teaching — and, I suspect, learning — more exciting.

Because they make greater use of the students as resources of learning, active learning methods encourage students to interact more with one another. Of the students surveyed, 66% reported more (30.6%) or much more (35.5%) interaction with other students than they had had in other University classes. Project leaders repeatedly noted improvement in the social skills of students (including communication, listening, and teamwork) even in the course of a single academic quarter.

On-site visits to active learning classes indicated that students were eager to participate in class activities and work with other students. During one of our visits to a project class, a student said that he had always been afraid to speak up in class, and it was his active learning class that made him realize he had information important to other students and an obligation to share it with them.

Do active learning methods make a difference in the classroom environment? The answer is an unequivocable "yes." Active learning methods increase the number of opportunities students have for "hands-on" learning, promote student participation and facilitate student and student-teacher interaction.

Question 3: Do students learn as much in active learning classes as in classes using traditional teaching methods?

Most faculty members know what kinds of information and how much information can be imparted by their lecture methods because the instructor has virtually absolute control over the information. The most frequently asked questions in the Northwest Area Program workshops focused on comparisons of active learning methods in this respect. From all indications, active learning methods appear to allow students to learn at least as much as in traditional classes.

The best evidence comes from studies conducted independently by two Northwest Area project leaders. In one instance, the instructor used control groups to measure differences in the test scores of students in traditional lecture and active learning sections of the same course and found no significant difference in the test results of the two groups on identical exams. In another instance, an instructor compared test results from two active learning classes with the results from the same courses in previous years. In this case, the test results showed slight, but statistically significant improvement.

Northwest Area Program survey results support these findings. Students were asked

how much they learned from the active learning classes taken at the University. Over 50% of the students reported learning more (40.3%) or much more (10.7%), while only slightly over 7% reported learning less (7.2%) or much less (0%); 61% of the students in classes using learning groups reported they learned more as a result of working in the groups.

In addition, questionnaires completed by Northwest Area Program project leaders indicated that instructors in the program universally agreed that students appeared to have a fuller understanding of course materials as the result of active learning. Their comments suggest students' papers were more intellectually sophisticated and creative and that responses to essay exam questions indicated increased ability to relate concepts and factual materials. Surveys of faculty participants of Northwest Area Program workshops who had implemented active learning methods further attest to students' improvement in this respect.

In short, available evidence indicates that students learn at least as much in active learning classes as in traditional lecture classes. Instructors who have used both methods suggest that students' understanding of the material actually increases because by actively working with the subject matter, the students learn to apply abstract concepts.

Question 4: What changes in time, resources, and support requirements can be expected when implementing active learning?

Although there is no "hard" evidence to provide an answer to the questions of comparable time commitment, there is apparent agreement among instructors who have used active learning that the methods do not create a whole new set of demands on instructors or resources. While project leaders noted increased time requirements in preparing for the transition to active learning, most reported that active learning methods require essentially the same time commitments as do other teaching methods once established.

Active learning methods also appear to make little, if any, difference in the demands placed on classroom resources. What differences do occur result largely from the nature of the specific methods used (computer learning obviously requires computer equipment, use of primary sources implies provide access to artifacts, etc.). In most instances, the type and amount of resources can be determined by the individual instructor. Thought planning, and creativity can turn readily available materials into valuable learning resources.

By and large it appears that active learning methods require different but not necessarily more teaching supplements than traditional methods. Time normally spent preparing lectures may be spent designing learning activities; classrooms which have been arranged traditionally into straightened rows may need to be rearranged to facilitate more student interaction. Teaching assistants whose usual function is preparing and grading exams and papers may require some training to become more involved in day to day instruction. While making the transition to

active learning requires that an instructor rethink his or her use of resources and time. It does not appear to involve extraordinary additional demands.

Question 5: How do students respond to active learning methods?

Surveys of students in active learning classes indicate overwhelmingly favorable response to active learning techniques. Asked to compare the active learning course they were taking with other courses at the University, over 40% reported liking the course more (14.7%) or much more (27.4%). An additional 43% reported liking the course about the same as other courses; 75% of students working in learning groups reported they enjoyed the experience.

In addition, over 60% of the students indicated they would recommend the course to a friend with similar interests, and 79% reported the course stimulated their interest in the field of study. Interestingly, student receptivity to active learning methods seemed unaffected by their reports (42%) that active learning requires more effort of them than do traditional learning methods. As one student commented on the survey, "It seems like less effort even though you know you're working harder, because you get a chance to see the results of your work and to really do something with what you're learning."

As with any instructional [illegible]s, there were students who did not like the active learning approach as much as other approaches. Project leaders reported that negative responses were most notable in the first few active learning sessions. Most of the resistant students, they agreed, appeared to adjust quickly and indeed to enjoy the method after a few class periods. Adequate orientation to active learning methods is essential to achieving student support. Students need to know the purposes of the method and the assignments, as well as what will be expected of them in the course.

Enjoyment of the methods seems to have some interesting side results. Almost 90% of the students reported doing all (53.8%) or almost all (34.9%) of the outside work required for the course. During an on-site visit to one project class, a student reported that there was simply no way of avoiding the work because each day's activities were tied to the next. Several students also noted they felt a greater responsibility to be prepared for class because their peers expected them to contribute their "fair share" to group assignments and discussion. Students surveyed also reported that they were absent less (19%) or much less (17.1%) in the active learning class than in other University courses they had taken. (Forty-six percent reported approximately the same number of absences.)

Perhaps even more convincing than the aggregate survey results were the comments made by students during the interview sessions or on the open-ended section of the survey. Repeatedly, students expressed enthusiasm about active learning (e.g. "This has been an outstanding experience.", "I never thought I'd get this excited about school work.").

Active learning methods are apparently well-received by the vast majority of students. Side benefits of this enthusiasm include decreased absenteeism, increased motivation, and greater student responsibility for learning.

Question 6: Is making the transition to active learning worth the effort?

The best evidence we have gathered suggests that active learning offers many rewards to an instructor willing to make the necessary changes. As other authors in this handbook have testified, students are more enthusiastic, more self-reliant, and by all available evidence better able to make use of the information they have acquired. For teachers, that is reward enough.

Evaluation Procedures

During the three-year project of the Northwest Area Program on Active Learning, 20 projects received grants to support the development of active learning in undergraduate classes. The faculty members who directed these projects and their students provided much of the information for our evaluation efforts. Faculty were asked to complete questionnaires following each academic quarter of the 1984-85 school year and to submit final reports discussing their experiences in implementing active learning. Surveys were gathered from 691 students enrolled in project classes in the winter and spring quarters of 1985. On-site visits were made to at least one class session of the project classes to observe the levels of activity and interaction among students and between students and the instructor; and informal interviews were conducted with teaching assistants and randomly selected students.

In addition, surveys were mailed to 113 faculty participants in Northwest Area Program workshops and seminars asking them a variety of questions about their experiences with traditional and active learning teaching methods. Responses were received from 62 faculty members of diverse academic rank and from a wide range of academic disciplines.

Northwest Area Program on Active Learning: History and Projects

Russell Christensen

History

In the winter of 1982, interviews with University of Minnesota faculty members found two major concerns: 1) the passive role of students in their undergraduate education and 2) an impersonal learning environment. The many large classes at the undergraduate level and the prevalence of the lecturing format affected student participation. Students were acting as if learning was a passive acquisition of information, not a process of active inquiry. Their active and interactive opportunities were further curtailed by students' time given to commuting (35% of the student body) and to part- or full-time work (75%).

Moreover, there was the faculty perception that while undergraduates were often poised to recall and relay numerous facts, they probably retained only a portion of these beyond the final examination. Students did not have much opportunity to manipulate or apply information learned, to combine these data into a larger view, to make inferences or collaborative judgments from them, defending them against a professor or fellow students. Such students, while they earn a degree, might well arrive in their first job struggling just to conceptualize a problem, let alone to solve it.

It was to address these needs that the Northwest Area Foundation authorized a three-year, declining grant to the University

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[illegible] grant for improving undergraduate education recognized, in the words of its proposal, that "[t]he discussion, dialogue, [t]he give and take of genuine intellectual exchange between students and between students and faculty members is essential to the growth an undergraduate education should foster. . . Students learn from venturing — venturing ideas, interpretations, hypotheses, questions, arguments, criticisms, conjectures — and from responding to others' ventures, and from replying to others' responses to their ventures, and so on. This is what we mean by active learning. . ."

The exploration and development of active learning consisted in:

a) conducting a competitive grants program for departments,
b) organizing summer workshops on active learning strategies, and
c) promoting a forum for discussion by the whole University community of problems and issues in undergraduate education.

An experimental effort directed at departmental development, the program was limited to colleges offering baccalaureate programs; participating faculty came from the Morris, Duluth and Twin Cities campuses, especially those who were already accomplished teachers but who wanted to try out new teaching techniques.

Project Descriptions

The following 20 proposals were developed and supported through the Northwest Area Program on Active Learning.

Department of Mathematics

The mathematics faculty included cooperative group projects in the applied mathematics sequence. In these projects students applied mathematical skills to problems similar to those encountered in employment settings, e.g., models for safe and effective drug dosage. Computers were used to assist student groups in formulating mathematical models, applying mathematical techniques to obtain information about the models, and computing results. Student projects were evaluated on scientific validity, clarity, and exposition.

Contact: Warren S. Loud, 109a Vincent Hall

Division of Social and Behavioral Sciences

General College expanded the development of group projects and laboratory sections used in teaching introductory psychology. This project made large sections (250 students) of introductory psychology more active by using student-led small group recitations, practice exercises, independent and group projects, and class demonstrations. Former students served as tutors. In the laboratory, students carried out experiments, analyzed data, and interpreted results. The instructor assumed the role of instructional manager.

Contact: Thomas Brothen, 253a Nicholson

Institute of Child Development

The Institute of Child Development designed one section of introductory psychology to include student active learning teams. Students discussed main points from the lecture, took quizzes on weekly readings, developed questions for future quizzes, and shared relevant personal experiences through discussion of class notebooks. These small group sessions were led by specially trained graduate and undergraduate teaching apprentices.

Contact: William R. Charlesworth, 186 Child Development

Department of Civil and Mineral Engineering

Civil and mineral engineering faculty combined student learning groups and the use of microcomputers in practical civil engineering problem solving instructional modules. Student teams were instructed in cooperative problem solving and in using the microcomputer. The modules affected the learning of engineering problem solving methods, computer literacy, the use of mathematical principles and decision making, leadership, and communication skills. Included in project activities was a faculty workshop on promoting cooperative problem solving among students and the use of microcomputers in instruction.

Contact: Karl A. Smith, 103c Mineral Resources Research Center

School of Architecture and the Center for Urban and Regional Affairs
The School of Architecture and the Center for Urban and Regional Affairs tested a program which involves advanced undergraduates in the solution of problems in outstate Minnesota communities. Students in urban studies, geography, sociology, architecture, family social science, agriculture, applied economics, and design, were among expected participants. A faculty coordinator established working relationships with selected towns, and interdisciplinary student teams worked with local community people and professionals to help define community problems, recognize conflicts, and seek solutions.
Contact: Peggy Sand, 205 North Hall

Department of Animal Science
The Animal Science faculty moved Animal Breeding (AnSc 3220) from a lecture based course to a cooperative team approach. Teams of 12 students worked on class projects aided by weekly meetings with the faculty instructor, audio-visual tutorial materials, computer assisted instruction, and field trips to University genetic research units. Each week, the entire class of six teams (72 students) met to present their projects and to debate their views. Advanced undergraduates served as tutors and field trip guides.
Contact: William E. Rempel, 125 Peters Hall

Department of Geography
Geography faculty developed a 2-credit proseminar designed to introduce advanced undergraduate students to faculty research interests, the nature of geographic inquiry, approaches to research, and the formulation of research problems and strategies. The mechanics of research and exposition were taught through the assignment of reports: preparation of an annotated bibliography, preparation of a research proposal, and development of a preliminary outline for a senior project. The proseminar was followed by [illegible] quarters of non-credit tutorial sessions to aid students in the final preparation of their senior project.
Contact: Joseph E. Schwartzberg, 473 Social Sciences Building

Division of Science, Business and Mathematics
General College established cooperative learning groups in intermediate algebra to aid students in overcoming math anxiety and to achieve a higher level of competence in algebra. Student groups worked cooperatively answering problem assignments, comparing various problem solving techniques, and learning how to apply problem solving strategies to algebra.
Contact: Douglas F. Robertson, N285 Elliott Hall

Department of History
The History Department faculty developed microcomputer software packages centered on historical issues marked by scholarly debate. Students studied historical debate on the issues; developed testable hypotheses; tested their hypotheses using a previously compiled microcomputer data set, e.g., historical demography, voting patterns, census data; described changes over time, and explored social, political and cultural implications. Once developed, the packages were available to a variety of upper division history courses.
Contact: Russell Menard, 614 Social Sciences Building

University of Minnesota, Morris
The Morris campus faculty completed development of the freshman seminar program connections. Twelve faculty members developed seminar topics united by a common theme. Freshmen were introduced to issues of current academic and public concern through informal, but informed discussion of the topics with the faculty members and other students. During the second quarter of the 1-credit seminar, students took primary responsibility for shaping the direction of the seminars.
Contact: Wilbert Ahern, 118 Camden Hall, Morris Campus

Supportive Services Program, University of Minnesota-Duluth
The Supportive Services Program on the Duluth campus integrated the Feuerstein Instrumental Enrichment technique into its skill development courses. The technique taught problem solving, critical thinking, and communication through active involvement with materials and exercises, and specifically addressed the transferability of analytical strategies to all academic and real-world situations.
Contact: Diane Chambers, 138 Library, Duluth Campus

Department of Sociology, University of Minnesota-Duluth
The sociology faculty on the Duluth campus redesigned Introduction to Sociology to emphasize application and method of inquiry rather than description. The primary aims were to involve students in the practice and application of sociology and to integrate sociology with other social science disciplines. The grant was used to support the development of teaching materials, and to incorporate directed learning activities, independent and group projects, experiments, observations, and library research into the course.
Contact: William A. Fleishman, 228 Cina Hall, Duluth Campus

Program in American Studies
Active learning strategies were developed to supplement the curriculum of the newly designed introductory sequence in American studies (AmSt 1001, 1002, 1003). Instructional units revolved around the presentation of four types of material: a document, an event, a location, and an artifact. The active learning strategies were designed so that students became involved in the interpretation and integration of the materials. Students developed team work, communication, problem solving and analytical skills. Students also gained an introduction to the interdisciplinary study of culture, learned how to integrate different types of sources, and gained insights into cultural issues that transcend traditional disciplinary boundaries.
Contact: Elaine Tyler May, 205 Scott Hall

Department of East Asian Studies
A change in the traditional roles of both Chinese language teachers and students was the focus of the East Asian Studies project. Students learned Chinese by actively employing communicative learning strategies in pair and small group activities with set tasks and goals. The instructor functioned primarily as a model, guide and a manager of student speaking ability. This project represented a shift from mastery of grammatical structures to the grasp of the appropriate use of such structures in communication.
Contact: [illegible] Huters, 113 Folwell Hall

Department of Child and Family Development, University of Minnesota-Duluth
An active learning component was added to a course in human diversity in the College of Education and Human Services Professions (UMD). These strategies provided an opportunity for active participation in simulations, role play and small group problem solving. Three hundred students per year were expected to take this course in fulfilling an NCATE requirement.
Contact: Terrie M. Shannon, 125 Bohannon Hall, Duluth Campus

Department of Educational Psychology
Small group interaction, cooperative groups tasks, experiential learning, and active experimentation became the primary instructional methods for a course in education psychology for students studying to be junior and senior high school teachers. The focus of the development activities was on making the course materials more relevant to the practical professional setting of school teaching. These modifications were accomplished through a collaboration between curriculum and instruction faculty and faculty in psychological foundations.
Contact: James Rest, 206a Burton Hall

Department of English

Defining the role of teaching assistants in American literature survey courses was the focus of this project. Special training was provided for the teaching assistants during September. The training focused on learning group methods and strategies for teaching literature, in order to enable the teaching assistants to make a more active contribution to the courses.
Contact: Donald Ross, 209 Lind Hall

Department of Strategic Management and Organization

A School of Management pilot seminar, organized by undergraduates [illegible]ded by a faculty member, was to create a worldwide network of business schools for the exchange of information on management theory and practice. Problems or case studies from each of 15 countries were to be rotated among participating groups in the various countries. The problems and their solutions would be evaluated by a local interpretative panel of business and area specialists.
Contact: Stuart Albert, 1208 Management/Economics Building

Department of Agronomy and Plant Genetics

It was planned that micro-computer software modules would teach crop management decision-making and problem-solving skills in undergraduate agronomy courses. The modules were to be used to introduce a variety of decisions normally required during the growing season; for example, the selection of the best crops, seedbed preparation, weed control, harvest methods, and pasture management.
Contact: Vernon Cardwell, 101 Agronomy

Division of Social and Behavioral Sciences

A "fast start, strong finish" was the goal of this two-pronged project in General College, designed to demonstrate the elements of the active learning strategies developed last year for introductory psychology. In the introductory economics sequence students solved projects in a setting that allowed them to learn collaborative skills as well as graphic and mathematical problem-solving skills.
Contact: Barbara Millen, 252 Nicholson Hall

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