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COOPERATIVE LEARNING: AN ALTERNATIVE TO TEACHING AT A MEDIEVAL UNIVERSITY

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Abstract

Until recently, the accepted model of instruction was based on a hidden assumption that knowledge can be transferred more or less intact from the mind of the teacher to the mind of the learn. Cognitive scientists now believe in a constructivist theory of knowledge, which can be summarized as follows: **Knowledge is constructed in the mind of the learner** (Bodner, 1986). This paper examines some of the implications of this statement, with particular emphasis on how a shift can be made from 'someone who teaches' to 'someone who tries to facilitate learning.' A shift from teaching by imposition to teaching by negotiation. A shift from the traditional structure of instruction in mathematics and science courses at the tertiary level, which is a direct descendent of the techniques introduced in medieval universities, to a classroom environment in which the students are active participants in the learning process. Particular attention is paid to what has been learned from evaluation of the techniques known as cooperative learning.

Origin of the Present System of Instruction

Our modern system of higher education evolved from medieval schools known as *studia generale*, which were created to educate clerks and monks beyond the level that could be achieved by cathedral and monastic schools. The first *studia* was created in Bologna toward the end of the 11th century. By the close of the 12th century, it consisted of four 'universities,' which were private societies formed to meet the needs of students who came to Bologna from four regions: Tuscany, Rome, Lombardy and Ultramontane.

The early universities in Bologna, Paris, Oxford, and so on, were free to govern themselves, but this freedom was achieved at the cost of having to raise their own finances. The teachers charged fees, and therefore had to please their students to earn a livelihood. (Cambridge University, for example, was established in 1209 by a group of

dissatisfied students who moved there from Oxford.) These universities focused on preparing men for careers in service to either Church or State. All students began with the same curriculum: grammar (Latin), logic, and rhetoric. They then went on to major in either law, medicine, or theology. Graduation depended on a single final examination, which most students failed.

Whole-Class Noninteractive Modes of Instruction

Reflect back on your undergraduate experience. To what extent were the science and mathematics courses you took based on the format introduced in medieval universities — a series of lectures in which scholars tried to summarize the state of knowledge in their area of expertise? When this format was first implemented, there was no alternative. Books were rare; individual ownership of books even rarer.

Lectures are still the best way to introduce information when our role is the same as that of the 'masters' who taught at the early universities — when we bring together information from a number of sources to which the audience does not have access. But this is not the case in undergraduate science and mathematics courses, where our students have access to excellent texts that provide them with more than enough information.

The traditional lecture approach to instruction can be characterized in terms of the coordinate system shown in Figure 1. Lectures represent a whole-class, teacher-centered, noninteractive mode of instruction. They address the whole class at the same time; all decisions about the topics to be covered, the order in which they are presented, and the amount of time devoted to each topic is controlled by the instructor; and interactions between the instructor and students are rare, if not nonexistent.

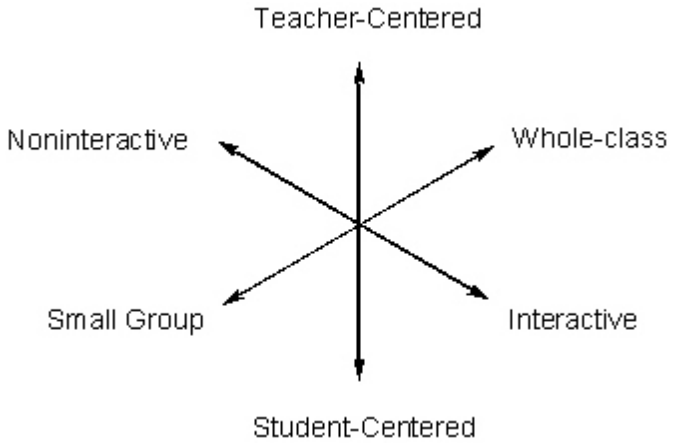

Figure 1

As part of a description of her experiences as a graduate student, Metz (1988) described one course as follows:

> [This course was] the most frustrating of all. ... My frustration as a teacher started to mount when a student asked some questions on a point he did not understand. The professor responded to the first, then said he could not answer other questions because he had material to cover and had limited time to do so. ... Several days later when this same student raised his hand, he was ignored. No one ever again attempted to ask a question.

She then concluded with a phrase that characterizes all too many whole-class, teacher-centered, noninteractive classrooms.

> The next point of frustration was the lecture notes. At times I felt the professor's notes became my notes without passing through either of our minds.

Whole-Class Interactive Modes of Instruction

As part of a study of exemplary practice in teaching, Tobin and co-workers described the classroom behavior of teachers they referred to as 'Doug' and 'Gary' (Tobin and Fraser, 1987). Doug believed that:

- It is important for students to *understand* what they learn and to *retain* this knowledge..
- This can best be achieved by presenting the material in the syllabus, explaining this material, and helping students identify the logical structure of chemistry.
- The ability to explain new material to our students is a critical factor in our effectiveness as teachers.

Many who share these beliefs approach instruction from a whole-class, teacher-centered, noninteractive mode. They take the burden of learning onto themselves and dominate what happens in the classroom. When students fail, they conclude that they have failed or that the students were either too lazy or did not have the cognitive skills to succeed.

An observer watching Doug's classes would find that he often used a 'lecture' mode of instruction. (It is difficult to imagine a classroom in which this mode is not present, at least some of the time.) One of the keys to Doug's success, however, was his ability to also use an **interactive** mode of instruction. The focus of attention was still the whole class and the classroom environment was still predominantly teacher-centered, but now Doug was involved in a dialogue with his students.

To help the students to 'understand' the material they were learning, Doug made extensive use of questions to develop the content of his lessons, to probe whether students understood the material, and to involve the students in the learning process. These teacher-initiated questions were asked in a nonthreatening atmosphere, in which the risk of an inappropriate response was minimized. Doug also encouraged his students to ask questions. (In some lessons, students asked more than 60% of the questions, transforming the classroom environment along the coordinate system in Figure 1 toward

one that was more student-centered.) His students considered the most useful classes to be those in which the frequency of student-initiated questions was high. (Even students who did not ask questions valued the questions their peers asked.) Another important feature of the interactive mode of instruction in Doug's class was the tendency of the students to spontaneously take over the class and answer questions raised by other students.

Interactive Instruction in Large Classes

Some might argue that an interactive mode of instruction based on extensive use of questions is fine for Doug, who has only a limited number of students in each of his high-school classes. But what about those of us who teach hundreds of students at a time?

To study what happens when interactive techniques are used in large courses, Metz (1988) compared the performance of students in a teacher-centered lecture with a student-centered interactive class. The instructors selected to run these sections had the same amount of experience, but different natural teaching styles. The 384 students in the study were all registered in the same course, but they were divided into two groups who attended class in different rooms.

Most students were exposed to a classical teacher-centered approach to instruction, where student-teacher interactions were kept to a minimum. Lectures were presented using a chalkboard or an overhead projector. Demonstrations were done, but students were not actively involved. Few questions, except of a rhetorical nature, were asked and few questions were encouraged from the students.

The instructor in the interactive class tried to maximize student involvement while minimizing his own. He started each class by briefly presenting the topic. He then provided the students with a whole-class or small-group activity and devoted his time to directing, clarifying and providing feedback to students, as necessary.

Students in both sections were given the same exams, which were written by the individual who taught the lecture section. The performance of the two sections on the exams was virtually identical, but there were clear differences in the attitudes of the students.

Students in the interactive class were more likely to indicate that they had little time to think about anything besides chemistry during class; to find it helpful when the lecturer asks questions that must be answered by the students before he or she continues; to feel challenged to think about the material being discussed during lecture; to feel comfortable about being called on to answer questions during class; and to want to take another chemistry course taught by the same format. They were also more likely to believe the course was taught at an appropriate level and that adequate material was presented in lecture to prepare them for exams.

Student behavior in the interactive class went through three stages. The initial stage, which lasted for three classes, was characterized by ambiguity and anxiety on the part of the students, who came into the course expecting to sit back and take notes. Students behavior in this stage included: looking away from the instructor when questions were asked; waiting for others to answer questions; raising their hands instead of calling out answers; responding to questions only when they were sure of their answers; asking few questions themselves; and refraining from correcting errors made by the instructor or other students.

The next stage, which lasted until the first exam, involved a transition from teacher dependence to student independence. This stage was characterized by the following kinds of student behavior: asking questions; trying to answer questions even when not sure of the answer; answering questions without being called on; talking within a group; and talking between groups of students. During this stage, the students finally accepted that the instructor was not going to tell them everything they needed to know for the exam and that it was up to them to take responsibility for their learning.

After the first exam, the students reached the final or working stage, in which they assumed an active role in class. They realized that other students in the class had similar problems with chemistry and that they could possibly help each other. It was during this stage that student-teacher and student-student interactions were at their highest. These interactions included: correcting errors made by the instructor, other students, or themselves; checking with neighbors before asking the instructor for help; asking more **why** and **how** questions; moving over to work with other students without being told to do so; continuing to work on problems as a group even after a whole-class discussion was resumed; asking for more clarification of problems and explanations — even interrupting the instructor to do so; starting to work on problems before the directions were completed; answering questions from other students before the instructor could respond to the questions; and answering questions — even rhetorical ones — without waiting to be called on.

Small-group Interactive Modes of Instruction

The techniques discussed so far all focus on the class as a whole. Tobin's study of exemplary practices presented a case study of a chemistry teacher who used an alternative approach to instruction. Like Doug, Gary believed it was important for students to understand the material they were learning. But he believed this could only be achieved if they accepted responsibility for their own learning. Gary therefore allocated a higher proportion of his class time to individualized and small-group work. Like Doug, he constantly interacted with students, but his interactions were more likely to be one-on-one.

Students in Gary's classes frequently organized themselves into small-groups, which were characterized by very high levels of student-student interaction. The students discussed ideas within these groups and asked each other questions about things they did not understand. They were quite willing to help one another and responded favorably to small-group activities when interviewed.

Cooperative, Competitive, and Individualistic Learning

The different modes of instruction discussed in this paper can be analyzed in terms of a theory developed by Kurt Lewin (1935) for understanding how individuals are motivated to work toward the accomplishment of their goals that was extended to interpersonal situations by Morton Deutsch (1949).

Deutsch identified three ways in which the motivations of different individuals can be interrelated. A **cooperative** situation is one in which an individual can only achieve his or her goals if the other members of the group also attain their goals. In a **competitive** situation, individuals can only achieve their goals when others in the group cannot. In an **individualistic** situation, there is no correlation among the ability of members of a group to attain their goals.

This model provides a theoretical basis for understanding the effect of different modes of instruction. There is no doubt that learning requires work and that the extent to which students apply themselves to learning is a function of their motivation. When a student finds a particular subject interesting, the student often possesses an intrinsic motivation to learn. Although talented teachers can make almost any topic seem interesting, no subject is inherently interesting to all students. Schools have therefore developed ways of motivating students. The most common of these extrinsic motivators involve grades.

Grades are successful as extrinsic motivators only when they are given on a competitive basis. But, as Slavin (1984, 1988) notes, competition among students creates a situation in which:

- Students hope their classmates do poorly, so that they can do well.
- There is peer-group pressure not to do too well, thereby raising the curve.
- Students who excel are often looked on with disfavor by their peers.

If we believe that students must accept responsibility for learning, and that competitive situations can discourage students from doing their best, the obvious solution might seem to be individualized instruction, in which students work at their own pace through a program of carefully sequenced activities. This technique seems particularly suited for use in mathematics and the physical sciences, where each new skill builds on prior knowledge.

Research on programmed instruction, however, suggests that this technique does not meet our expectations. There are many reasons for this (Slavin, Leavey, and Madden, 1984).

- Students find it boring, because it forces them to interact with paper, not people.
- It isolates students from one another.
- Students tend to get bogged down as the tasks become familiar, and therefore monotonous.
- There is no incentive to progress rapidly.

- The teacher is relegated to the role of nothing more than an answer-checker.

Vygotsky (1986) provided a theoretical framework for understanding how forcing students to work by themselves can actually limit the amount that can be learned. The best example of the problems with programmed instruction is the case study done by Erlwanger (1972) on 'Benny,' a young mathematics student who, on the basis of extensive seatwork, constructed knowledge about the mathematics of fractions that some researchers would call a 'less powerful' concept, but practicing teachers would label as 'wrong.'

This leaves us with a third goal structure to consider: cooperative learning, which is the basis for both Doug's whole-class interactive mode of instruction and Gary's use of small-group activities.

The Theory of Cooperative Learning

A theoretical model based on the work of Piaget has been proposed to explain why cooperative learning might improve student achievement (Damon, 1984). This model suggests that the group discussions that occur during cooperative learning achieve the following.

- They expose inadequate or inappropriate reasoning, which results in disequilibration that can lead to better understanding.
- They motivate individuals to abandon misconcepts and search for more powerful concepts.
- They provide a forum that encourages critical thinking.
- They lead to constructive controversy, which focuses students' thinking and increases the use of higher-order cognitive processes.
- They encourage students to vocalize ideas, which inevitably improves their performance.

According to this model, the most important element of cooperative learning is the fact that students work together in groups in which they are involved in discourse about the course content they are struggling to learn.

A separate model has been proposed from the perspective of the theory of motivation, which attributes the success of group learning to the goal structure of cooperative learning (Slavin, 1984, 1987, 1988). This model proposes that cooperative learning activities, when properly carried out, create a situation in which the only way individual group members can attain their goals is if the group is successful. To meet their own goals, members of the group therefore help their classmates do whatever is necessary to succeed. According to this theory, cooperative learning encourages students to want their classmates to succeed, in sharp contrast to the situation when individuals compete for grades.

Effect of Cooperative Learning

Cooperative learning has been shown to improve student achievement (Johnson, Maruyama, Johnson, Nelson, and Skon, 1981). They have also been shown to increase the use of higher-order cognitive skills (Gabbert, Johnson, and Johnson, 1986) that then transfer to individual learning situations because whole-class interactive and small-group approaches help students develop strategies for solving problems that their peers in competitive or individualistic environments only experience second-hand (Ross, 1988).

When high-, medium-, and low-achieving students are compared, it is the low- and medium-achievers who seem to benefit most from cooperative learning (Johnson, Johnson, Roy, and Zaidman, 1985). Thus, it is not surprising that cooperative learning has been found to improve students' self-esteem (Johnson and Johnson, 1979). The performance of the high-achievers is usually the same in both competitive and cooperative learning situations. However, when these students are interviewed they report feeling more support and encouragement from their peers and the teacher when they work in groups.

Some have argued that cooperative learning should be used, even if it had no impact on student achievement (Slavin, 1984), because of the way it improves the relationships between males and females (Waring, Johnson, Maruyama, and Johnson, 1985) and among different ethnic and racial groups (Sharan, 1980; Johnson, Johnson, Tiffany, and Zaidman, 1984).

An equally compelling argument can be made for cooperative learning on the basis of the effect it can have on reducing students' anxiety about science and mathematics (Stodolsky, 1985) by creating a relaxed, tension-free atmosphere, in which a feeling of mutual trust prevails (Okebukola, 1986).

Implementing Cooperative Learning

If you choose to include an element of cooperative learning in your course, you might wish to consider the following answers to common questions, which summarize the results of a variety of research studies (Johnson and Johnson., 1979; Sharan, 1980, 1983; Johnson, et al., 1984; Johnson, et al., 1985; Waring, et al., 1985).

How are groups constructed?

> Groups should contain between three and five members. If the group is too small, one member can dominate the others. If it is too large, the group will ignore the contributions of one or more members. The group should be heterogeneous. It should include high-, medium-, and low-achievers; both males and females; and members of different ethnic groups, if possible. The more heterogeneous the group, the larger its resources for problem solving.

What are the essential elements of group work?

Cooperative learning assumes that the success of each individual depends on other members of the group. This can be achieved by sharing mutual goals, resources, and rewards. It can also be accomplished by giving each member of the group a specific task whose completion is essential to the group's success.

How do I get students to work in groups?

It might help to impose the following rules. Members of the group should share their information with each other; encourage other members of the group; bring out the ideas of other group members; argue their own point of view; be critical of ideas, not people; and make sure they understand the views of other members of their group.

How do I assess cooperative learning?

The group can produce a single product for which all members receive the same grade. (This approach is used in many of the General Chemistry courses at Purdue, in which lab reports are submitted by groups of three students.) Alternatively, and some would argue preferentially, small-group activities can be used to enhance learning and testing for grades can then be done on an individual basis. This combination reflects the notion that the optimum use of small-group activities requires both cooperative learning and individual accountability. (Recently, we studied what happens when groups of students were allowed to discuss their Organic Chemistry exams for up to 30 minutes before they split up to write their individual answers. We found significant differences in the answers members of a group gave to individual questions, and the test scores of these students. But we also found a significant improvement in the extent to which all of the students seemed to understand the questions they were answering.)

What is the relationship between groups?

It is possible to construct modes of instruction based on both **intergroup cooperation** and **intergroup competition**. The first can be fostered by asking the students to think about questions such as: 'What do we need to do to make sure everyone in the class does a good job learning?' The second is much easier to achieve. Have them reflect on the following question: 'What can we do to make sure that our group is best?' Those who have played team sports know the value of intergroup competition. It is worth noting, however, that *intergroup cooperation* is less likely to accentuate the importance of status and ability within groups. It therefore enhances learning by students with less ability or by those from minority groups.

What do I have to do as the teacher to implement group work?

> Your role is to notice when a group consistently leaves one member out, to stop the group's work, and point out that they are losing valuable resources. More importantly, you will have to learn how to relinquish your role as the primary dispenser of knowledge and control. You must be willing to decentralize authority in the classroom.

Conclusion

To some, 'cooperative learning' means the small-group, interactive approach that characterized Gary's classroom or the aspect of small-group work incorporated into large lecture sections in Metz's study. In its broadest sense, however, it can include the teacher-facilitated 'cooperative learning' that occurs during the dialogue between students and teacher in Doug's class.

Cooperative learning should not be viewed as a threat to the instructor, or a way of replacing a dedicated teacher with another form of a 'teacher-proof curriculum.' Incorporating cooperative learning into one's classroom can begin as nothing more than a shift from the top of the coordinate system in Figure 1 along one or more axes toward the bottom. For some, it is a shift away from whole-class toward small-group instruction, for others it is a shift toward a student-centered classroom. What is most important is a shift toward an interactive environment, in which student-student and student-teacher interactions are maximized. Regardless of the axis (or axes) along which the shift takes place, the goal of cooperative learning is the same — to transform the instructor from 'someone who teaches' to 'someone who facilitates learning.'

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