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Cooperative Learning Models for the 3 R's

Cooperative learning can be used successfully as the primary instructional method in reading, writing, and mathematics.

In 1980 at Johns Hopkins University we began to develop and evaluate cooperative learning programs designed specifically for particular subjects and grade levels. We set out with several critical objectives. First, we wanted to use what we had learned about cooperative learning to try to solve fundamental problems of instruction, such as accommodating individual differences in reading and math. In particular, we wanted to design programs that could be used in heterogeneous classes, to reduce the need for special education or tracking. Second, we wanted to design cooperative learning programs that could be used all year, not just from time to time as part of a teacher's bag of tricks. Third, we wanted to incorporate knowledge about curriculum- and domain-specific learning into our cooperative approaches, such as the teaching of story grammar and summarizing in reading, or the writing process in writing.

The programs we developed, Team Assisted Individualization (TAI) in mathematics and Cooperative Integrated Reading and Composition (CIRC), are among the best researched and most effective of all cooperative learning methods. This article describes TAI and CIRC and the research on them.

Team Assisted Individualization

The first comprehensive cooperative learning model we developed and researched was Team Assisted Individualization—Mathematics,[1] a program that combines cooperative learning with individualized instruction to meet the needs of diverse classrooms (Slavin 1985b).

We developed TAI for several reasons. First, we hoped TAI would provide a means of combining the motivational power and peer assistance of cooperative learning with an individualized instructional program—one that would provide all students with materials appropriate to their levels of skill and allow them to proceed through these materials at their own rates. Second, TAI was developed to apply cooperative learning techniques to solve many of the problems of individualized instruction.

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In the 1960s, individualized instruction and related methods had been expected to revolutionize instruction, especially in mathematics. However, reviews of the research on these instruction methods in mathematics have consistently concluded that these methods are no more effective than traditional instruction (see, for example, Miller 1976, Horak 1981). Several problems inherent in programmed instruction have been cited as contributing to these disappointing findings: too much time spent on management rather than teaching, too little incentive for students to progress rapidly through the programmed materials, and excessive reliance on written instruction rather than instruction from a teacher.

We felt that by combining programmed instruction with cooperative learning and turning most of the management functions (for example, scoring answers, locating and filing materials, keeping records, assigning new work) over to the students themselves,

these problems could be solved. If students could handle most of the checking and management, the teacher would be free to teach individuals and small homogeneous teaching groups. Students working in learning teams toward a cooperative goal could help one another study, provide instant feedback to one another, and encourage one another to proceed rapidly and accurately through the materials.

Finally, TAI was developed as a means of producing the well-documented social effects characteristic of cooperative learning (Slavin in press) while meeting diverse needs. Our principal concern here was mainstreaming. We felt that mainstreaming of academically handicapped students in mathematics was limited by the belief of regular class teachers that they were unprepared to accommodate the instructional needs of these students (see Gickling and Theobald 1975). Further, studies of attitudes toward academically handicapped students had consistently found that these students are not well accepted by their nonhandicapped classmates (see Gottlieb and Leyser 1981).

Since cooperative learning methods have had positive effects on social relations of all kinds, specifically on relationships between handicapped and nonhandicapped students (Madden and Slavin 1983), we felt that the best possible mathematics program for the mainstreamed classroom would be one that combined cooperative learning with individualized instruction (see Madden and Slavin 1983). Recently, as many districts have moved away from tracking toward heterogeneous classes, the need for effective programs that can accommodate mathematics instruction to diverse needs has increased.

Principal Features of TAI. TAI is designed primarily for grades 3–6, but it has been used at higher grade levels (up to the community college level) for groups of students not ready for a full algebra course. It is almost always used without aides, volunteers, or other assistance. The principal elements of TAI are as follows (adapted from Slavin et al. 1986):

If students handle most of the checking and management, the teacher is free to teach individuals and small homogeneous groups.

Teams. Students are assigned to four- to five-member teams. Each team has a mix of high, average, and low achievers, boys and girls, and students of any ethnic groups in the class. Every eight weeks, students are reassigned to new teams.

Placement test. At the beginning of the program, students are pretested on mathematics operations. They are placed at the appropriate point in the individualized program based on their performance on the placement test.

Curriculum materials. Following instruction from the teacher (see "Teaching groups," below), students work in their teams on self-instructional curriculum materials covering addition, subtraction, multiplication, division, numeration, decimals, fractions, word problems, statistics, and algebra. The units are in the form of books. Each unit has the following parts:

- a guide page that reviews the teacher's lesson, explaining the skill to be mastered and giving a step-by-step method for solving the problems;
- several skill practice pages, each consisting of 16 problems. Each skill practice page introduces a subskill that leads to a final mastery of the entire skill;
- formative tests A and B (two parallel 10-item sets);
- a unit test of 15 items;
- answer sheets for the skill practice pages and formative tests (located at the back of student books) and answers for unit tests (located in a separate "monitor book").

Word problems are emphasized throughout the materials.

Teaching groups. Every day, the teacher teaches lessons to small groups of students (drawn from the heterogeneous teams) who are at the same point in the curriculum. Teachers use specific concept lessons provided as part of the program. The purpose of these sessions is to introduce major concepts to the students. Teachers make extensive use of manipulatives, diagrams, and demonstrations. The lessons are designed to help students understand the connection between the mathematics they are doing and familiar real-life problems.

While the teacher works with a teaching group, the other students continue to work in their teams on their self-instructional units. This direct instruction to teaching groups is possible because students take responsibility for almost all checking, handling of materials, and routing.

Team study method. Following the placement test, the students are given a starting place in the sequence of mathematics units. They work on their units in their teams, using the following steps:

1. Students locate their units within their books and read the guide page, asking teammates or the teacher for help if necessary. Then the students begin with the first skill practice page in their unit.

2. Each student works the first four problems on his or her own skill practice page and then has a teammate check the answers against an answer sheet printed upside-down at the back of each student book. If all four are correct, the student may go on to the next skill practice page. If any are incorrect, the student must try the next four problems, and so on, until he or she gets one block of four problems correct. If they run into difficulties at this stage, students are encouraged to ask for help within their teams before asking the teacher for help.

3. When a student gets four in a row correct on the last skill practice page, he or she takes Formative Test A, a 10-item quiz that resembles the last skill practice page. Students work alone on the test until they are finished. A teammate scores the formative test. If the student gets 8 or more of the 10 problems correct, the teammate signs the student's paper to indicate that the student is certified by the team to take the unit test. If the student does not get 8 correct (this is rare), the teacher is called in to respond to any problems the student is having. The teacher would diagnose the student's problem and briefly reteach the skill, possibly asking the student to work again on certain skill practice items. The student then takes Formative Test B, a second 10-item test comparable in content and difficulty to Formative Test A.

4. When a student passes Formative Test A or B, he or she takes the test paper to a student monitor from a different team to get the appropriate unit test. The student then completes the unit test, and the monitor scores it. Two different students serve as monitors each day. If the student gets at least 12 items correct (out of 15), the monitor posts the score on the student's Team Summary sheet. Otherwise, the test is examined by the teacher, who meets with the student to diagnose and remediate the student's problems. Again, because students have already shown mastery on the skill practice pages and formative tests, they rarely fail a unit test.

Team scores and team recognition. At the end of each week, the teacher computes a team score. This score is based on the average number of units covered by each team member and the accuracy of the unit tests. Criteria are established for team performance. A high criterion is set for a team to be a "superteam," a moderate criterion is set for a team to be a "greatteam," and a minimum criterion is set for a team to be a "goodteam." The teams meeting the "superteam" and "greatteam" criteria receive attractive certificates.

Facts tests. Twice each week, the students are given three-minute facts tests (usually multiplication or division facts). The students are given fact sheets to study at home to prepare for these tests.

Whole-class units. Every three weeks, the teacher stops the individualized program and spends a week teaching lessons to the entire class covering such skills as geometry, measurement, sets, and problem-solving strategies.

Research on TAI. Seven field experiments have evaluated the effects of TAI on student achievement, attitudes, and behavior (see Slavin 1985a). Academic achievement outcomes were assessed in six of the seven studies. In five of these, TAI students significantly[2] exceeded control students on standardized (CTBS or CAT) Math Computations scales. Similar effects were found for Concepts and Applications in only one of the four studies in which this variable was assessed; but in all four studies, means for Concepts and Applications favored the TAI group. In the five studies in which the treatment effects for Computations were statistically significant, they were also quite large; on average, TAI classes gained twice as many grade equivalents as did control students. Effects of TAI were equally positive for high, average, and low achievers, and for academically handicapped as well as nonhandicapped students. Positive effects of TAI have also been found on such outcomes as self-concept in math, liking for math class, classroom behavior, race relations, and acceptance of mainstreamed academically handicapped students (Slavin 1985a).

In five of six studies, TAI students significantly exceeded control students on standardized Math Computation scales.

Cooperative Integrated Reading and Composition

Following the success of the TAI mathematics program, we turned to reading and writing/language arts, the two subjects that, with mathematics, constitute the core of the elementary school program. Because these subjects are very different from mathematics, our approach to applying cooperative learning to them was very different. For one thing, reading, writing, and language arts include subskills that each demand different approaches. For example, optimal procedures for teaching reading comprehension or vocabulary would certainly be different from those for teaching decoding, spelling, writing, or language mechanics.

The program we ultimately developed and researched is called Cooperative Integrated Reading and Composition, or CIRC (Madden et al. 1986a). Our development plan focused on using cooperative learning as a vehicle to introduce practices identified in recent research on reading and writing into routine classroom practice, and to embed cooperative learning within the fabric of the elementary reading and writing program (see Stevens et al. 1987).

Principal Features of CIRC. The CIRC program includes three principal elements: basal-related activities, direct instruction in reading comprehension, and integrated language arts/writing. In all of these activities, students work in heterogeneous learning teams.

Reading groups. Students are assigned to two or three reading groups (8–15 students per group) according to their reading level, as determined by their teachers.

Teams. Students are assigned to pairs (or triads) within their reading

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groups. The pairs are then assigned to teams composed of partnerships from two different reading groups. For example, a team might be composed of two students from the top reading group and two from the low group. Mainstreamed academically handicapped and remedial reading (for example, Chapter I) students are distributed among the teams.

Many of the activities within the teams are done in pairs, while others involve the whole team; even during pair activities, however, the other pair is available for assistance and encouragement. Most of the time, the teams work independently of the teacher, while the teacher either teaches reading groups drawn from the various teams or works with individuals.

Students' scores on all quizzes, compositions, and book reports contribute to a team score. Teams that meet an average criterion of 90 percent on all activities in a given week are designated "superteams" and receive attractive certificates; those that meet an average criterion of 80–89 percent are designated "greatteams" and receive less elaborate certificates.

Basal-related activities. Students use their regular basal readers (or whatever texts or reading materials are used in the school). Stories are introduced and discussed in teacher-led reading groups that meet for approximately 20 minutes each day. During these sessions, teachers set a purpose for reading, introduce new vocabulary, review old vocabulary, discuss the story after students have read it,

Cooperative Learning in Elementary School Science

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Science for Life and Living: Integrating Science, Technology, and Health is a new science program for elementary schools developed by the Biological Sciences Curriculum Study (BSCS) (Bybee and Landes 1988; in press). The program emphasizes concrete experiences; it gives students opportunities to observe phenomena, to record their observations, and to discuss them with other students. Cooperative learning is a central strategy of the program, for several reasons.

First, the Johnsons' research (1984, 1987a, 1987b) shows that cooperative learning enhances children's ability to construct knowledge. Working in groups gives children time to think and talk about what they are learning; they can carefully construct their knowledge of the world around them. In cooperative groups of two or three, each student can share experiences and thoughts with teammates; learning becomes more personal than in the traditional classroom.

Second, cooperative learning helps teachers with classroom management. Hands-on science requires that students interact with materials; and cooperative learning is structured so that students, not teachers, manage those materials. In a cooperative learning classroom, students help each other with assignments and problems, which alleviates some of the stress on the teacher to maintain order and to keep students on task.

A third benefit of cooperative learning is improved self-confidence for many students. Because many students do not feel comfortable taking the risk of being wrong in front of the entire class, they often say nothing at all. When working in small groups, however, more students risk speaking out. They then discover they have something important to contribute and that their ideas can be useful to others.

Fourth, science and technology are cooperative enterprises. Neil Armstrong was the first person to walk on the moon, but thousands of people in research, engineering, and industry labored for a decade to get him there. Cooperative learning reflects the way scientists themselves work in teams.

Of course, cooperative learning is not a magic wand to wave over students, but it can provide an effective framework for teaching about science, technology, and health. That is why it holds a prominent place in the new BSCS science curriculum.

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and so on. Presentation methods for each segment of the lesson are structured. For example, teachers are taught to use a vocabulary presentation procedure that requires a demonstration of understanding of word meaning by each individual, a review of methods of word attack, repetitive oral reading of vocabulary to achieve automaticity, and use of the meanings of the vocabulary words to help introduce the content of the story. Story discussions are structured to emphasize such skills as making and supporting predictions about the story and understanding major structural components of the story (for example, problem and solution in a narrative).

After the stories are introduced, the students are given a series of activities to do in their teams when they are not working with the teacher in a reading group. The sequence of activities is as follows:

1. *Partner reading*. First, students read the story silently, then take turns reading the story aloud with their partners, alternating readers after each paragraph. As his or her partner reads, the listener follows along and corrects any errors the reader makes.

2. *Story structure and story-related writing*. Students are given questions related to each narrative that emphasize story grammar. Halfway through the story, they are instructed to stop reading and to identify the characters, the setting, and the problem in the story, and to predict how the problem will be resolved. At the end of the story, students respond to the story as a whole and write a few paragraphs on a topic related to the story (for example, they might be asked to write a different ending to the story).

3. *Words out loud*. Students are given a list of new or difficult words used in the story, which they must be able to read correctly in any order without hesitating or stumbling. These words are presented by the teacher in the reading group, and then students practice their lists with their partners or other teammates until they can read them smoothly.

4. *Word meaning*. Students are given a list of story words that are new in their speaking vocabularies. They look them up in a dictionary, paraphrase the definitions, and write a sentence for each that shows the meaning of the word (i.e., "An *octopus* grabbed the swimmer with its eight long legs," not "I have an *octopus*").

5. *Story retell*. After reading the story and discussing it in their reading groups, students summarize the main points of the story to their partners. The partners have a list of essential story elements, which they use to check the completeness of the story summaries.

6. *Spelling*. Students pretest one another on a list of spelling words each week, and then work over the course of the week to help one another master the list. Students use a "disappearing list" strategy in which they make new lists of missed words after each assessment until the list disappears and they can go back to the full list, repeating the process as many times as necessary.

Partner checking. After students complete the activities listed above, their partners initial a student assignment form indicating that they have completed or achieved criterion on that task. Students are given daily expectations as to the number of activities to be completed, but they can go at their own rate and complete the activities earlier if they wish, creating additional time for independent reading (see below).

One key concern in the design of the CIRC program was to fully integrate the activities of special education and remedial reading teachers with those of regular classroom teachers.

Tests. At the end of three class periods, students are given a comprehension test on the story, are asked to write meaningful sentences for each vocabulary word, and are asked to read the word list aloud to the teacher. Students are not permitted to help one another on these tests. The test scores and evaluations of the story-related writing are major components of students' weekly team scores.

Direct instruction in reading comprehension. One day each week, students receive direct instruction from the teacher in reading comprehension skills such as identifying main ideas, drawing conclusions, and comparing and contrasting ideas. A special curriculum was designed for this purpose. After each lesson, students work on reading comprehension worksheets or games as a whole team, first gaining consensus on one set of worksheet items, then practicing independently, assessing one another's work, and discussing any remaining problems on a second set of items.

Independent reading. Students are asked to read a trade book of their choice every evening for at least 20 minutes. Parents initial forms indicating that students have read for the required time, and students contribute points to their teams if they submit a completed form each week. Students complete at least one book report every two weeks, for which they also receive team points. Independent reading and book reports replace all other homework in reading and language arts. If students complete their basal-related activities or other activities early, they may also read their independent reading books in class.

Integrated language arts and writing. During language arts periods, teachers use a specific language arts/

writing curriculum developed for the project. Students work on language arts in the same teams as in reading. During three one-hour sessions each week, students participate in a writers' workshop (Graves 1983), writing at their own pace on topics of their choice. Teachers present 10-minute mini-lessons at the beginning of each period on the writing process, style, or mechanics; for example, brainstorming for topics, conducting a peer revision conference, eliminating run-on sentences, or using quotations. Students spend the main part of the period planning, drafting, revising, editing, or publishing their writing.

Informal and formal peer and teacher conferences are held during this time. Ten minutes at the end of the hour are reserved for sharing and "celebration" of student writing. Teacher-directed lessons on specific aspects of writing, such as organizing a narrative or a descriptive paragraph, using specific sensory words in a description, and ensuring noun-verb agreement, are conducted during two periods each week, and students practice and master these skills in their teams.

Involvement of special education resource teachers and reading teachers. One key concern in the design of the CIRC program was to fully integrate the activities of special education resource teachers and remedial reading teachers (such as Chapter I teachers) with those of regular classroom teachers. This integration was done differently in the two evaluations of the full CIRC program. In the 12-week pilot study (Madden et al. 1986b), resource and remedial reading teachers removed students from their reading classes for part or all of the reading period and implemented the CIRC program in separate areas. However, in a 24-week full-scale evaluation (Stevens et al. 1987, Madden et. al. 1986b), the schools scheduled resource and remedial reading pullouts at times other than reading or language arts/writing periods. Special and remedial reading teachers attended the CIRC training sessions but did not use CIRC methods or materials in their pullout programs, except that they occasionally helped students with problems they were encountering in the CIRC program used in the regular class.

Cooperative learning is not only an innovation in itself, but also a catalyst for other needed changes in curriculum and instruction.

Research on CIRC. As of this writing, two studies have evaluated the impact of the full CIRC program. The first study (Madden et al. 1986b, Stevens et al. 1987) evaluated the full CIRC program over a 12-week period. Overall, the effects of the CIRC program on student achievement were quite positive. CIRC classes gained 30 to 36 percent of a grade equivalent more than control students in reading comprehension and reading vocabulary, 52 percent of a grade equivalent more in language expression, 25 percent of a grade equivalent more in language mechanics, and 72 percent of a grade equivalent more in spelling. On writing samples, CIRC students outperformed control students on ratings of organization, ideas, and mechanics. The effects of CIRC were equal for students at all levels of prior achievement: high, average, and low.

The second study (Stevens et al. 1987) was designed to evaluate the CIRC program in 3rd and 4th grade classes over a full school year, incorporating changes suggested by the pilot study. For the total samples involved, the results of Study 2 were even more positive than those of Study 1. On the reading comprehension, language expression, and language mechanics scales of the California Achievement Test, CIRC students gained significantly more than control students, averaging gains of almost two-thirds of a grade equivalent more than control students. Differences of 20 percent of a grade equivalent on reading vocabulary were not significant, however. On writing samples, CIRC students again outperformed control students on organization, ideas, and mechanics ratings.

Study 2 added informal reading inventories as measures of students' oral reading skills. CIRC students scored significantly higher than control students on word recognition, word analysis, fluency, error rate, and grade placement measures of the Durrell Informal Reading Inventory, with effect sizes ranging from 44 percent to 64 percent of a standard deviation. As in Study 1, the CIRC program produced equal gains for students initially high, average, and low in reading skills, although mainstreamed academically handicapped students made particularly impressive gains (Slavin et al. 1988).

A Primary Instructional Method

Research on TAI and CIRC has clearly supported the idea that complex, comprehensive approaches that combine cooperative learning with other instructional elements can be effective in increasing the achievement of all students in heterogeneous classes. Studies demonstrate that cooperative learning programs can be used as the primary instructional method in reading, writing, and mathematics—not just is an additional strategy to add to teachers' repertoires.

One important possibility opened up by the development of TAI and CIRC is the use of cooperative learning as the unifying element of *school* reform. Cooperative learning methods are critical elements of the cooperative school (Slavin 1987), a school-level change model that incorporates widespread use of cooperative learning, peer coaching, comprehensive

mainstreaming, and teacher involvement in decision making.

Comprehensive cooperative learning models can also serve as a vehicle for introducing developments from the fields of curriculum and educational psychology into routine classroom use. Cooperative learning provides a structure for incorporating identification of story elements, prediction, summarization, direct instruction in reading comprehension, and integration of reading and writing within the reading period. It provides a structure that can enhance the effectiveness and practicality of writing process methods or of adapting instruction to individual needs in mathematics. Thus cooperative learning is not only an innovation in itself, but also a catalyst for other needed changes in curriculum and instruction.

If educational methods are to effect major changes in student achievement, they must address many elements of classroom organization and instruction at the same time. TAI and CIRC are two examples of what the future may hold in applying the best knowledge we have to improving instruction methodology.□

[1]TAI is currently published under the title "Team Accelerated Instruction" by Charlesbridge Publishing, 85 Main St., Watertown, MA 02171.

[2]We use *significant* in the sense of *statistically significant* throughout this paper.

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