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ABSTRACT

The Team-Assisted Individualization (TAI) mathematics program has been developed in an attempt to make individualized instruction workable in the classroom by adding components of cooperative learning. This paper presents the rationale for the development of TAI and describes results of three field experiments conducted to assess the effect of TAI on student achievement, attitudes, and behavior. The experiments, which involved a total of 1,997 students in grades 3 through 6 (including mainstreamed students), demonstrated basic achievement effects of the program and a number of positive social and attitudinal effects. Results clearly indicated that TAI increases students' mathematics achievement more than traditional instructional methods and that TAI students gained more than their control counterparts on every achievement measure in every study, although the differences were not statistically significant on some subscales at some grade levels in the third experiment. In addition, the third experiment demonstrated that TAI could be used over an extended time period (most of a school year) as the primary means of mathematics instruction. Among the other results reported are those indicating that TAI can have a strong positive effect on the social acceptance and behavior of academically handicapped students. (JN)

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TEAM-ASSISTED INDIVIDUALIZATION: A COOPERATIVE LEARNING SOLUTION FOR ADAPTIVE INSTRUCTION IN MATHEMATICS

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The Center

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

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The Center also supports a Fellowships in Education Research program that provides opportunities for talented young researchers to conduct and publish significant research and encourages the participation of women and minorities in research on education.

This report, prepared by the School Organization Program, summarizes the research to-date conducted on the Team-Assisted Individualization mathematics program.

Abstract

The Team-Assisted Individualization (TAI) mathematics program has been developed in an attempt to make individualized instruction workable in the classroom by adding components of cooperative learning. This paper presents the rationale for the development of TAI and describes the results of three field experiments conducted to assess the effects of TAI on student achievement, attitudes, and behavior. The experiments involved a total of 1,997 students in grades three through six, and demonstrated basic achievement effects of the program and a number of positive social and attitudinal effects.

Acknowledgment

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The issue of whether and how to adapt instruction to individual differences in student ability or achievement has been a long-standing controversy in American education. At various times, opinions and practices have alternatively favored tracking, within-class ability grouping, programmed instruction, computer-assisted instruction, and mastery learning as ways to meet the individual instructional needs and readiness of every student. The need for individualization has been perceived as particularly great in mathematics, where learning of each skill depends in large part on mastery of prerequisite skills.

The rationale behind individualization of mathematics instruction is that students enter class with widely divergent knowledge, skills, and motivation. When the teacher presents a single lesson to a diverse group, it is likely that some students will not have the prerequisite skills to learn the lesson and will fail to profit from it. Others will already know the material or will learn it so quickly that additional time spent going over the lesson will be wasted for them. Karweit (1983) and Slavin (in press) have hypothesized that small, inconsistent effects of time-on-task on achievement (net of ability) are due at least in part to a lack of correspondence in group-paced instruction between what is taught and students' levels of readiness and individual learning rates.

Teaching a single lesson at a single pace to a heterogeneous class obviously incurs certain inefficiencies in the use of instructional time. In theory, maximum instructional efficiency should be achieved when material presented to students is exactly appropriate to their levels of readiness and proceeds at a pace that matches the students' abilities to assimilate information. The substantial effects of one-to-one tutoring on student achievement (see, for example, Glass, Cahen, Smith, and Filby, 1981) probably arise in part from the ability of the adult tutor to establish a level and pace of instruction that is closely tailored to the needs of the individual student being tutored.

However, students overwhelmingly are taught in class groups, not in individual tutoring sessions. Individualizing instruction in class groups entails costs in instructional efficiency that may equal or exceed the inefficiencies produced by the use of a single level and pace of instruction. For example, programmed instruction provides complete individualization of instruction, allowing students to procede at their own rates on materials appropriate to their level of prior knowledge. Yet programmed instruction inevitably reduces the amount of time that teachers spend in direct instruction and increases the amount of time that students do seatwork. Studies of group-paced instruction have found that time spent on seatwork is typically negatively associated with learning, while time spent on direct instruction has positive effects on learning (see Brophy, 1979; Good, 1979). Time spent checking materials and managing the program is largely time lost from instruction. Motivation is often lacking in programmed instruction, as students may place little value on progress for its own sake and may become bored with endless interaction with written materials alone (see Kepler and Randall, 1977, and Schoen, 1976, for discussions of the problems of programmed instruction).

Reviews of research on programmed instruction in mathematics (e.g., Miller, 1976; Schoen, 1976) conclude that programmed instruction is no more effective than traditional methods in increasing student achievement. Given the costs and difficulties of implementing programmed instruction, one might argue that this approach should be abandoned as unworkable and ineffective.

Yet the problems of student heterogeneity which programmed instruction was designed to address will not go away. If anything, classes are becoming more heterogeneous due to such movements as mainstreaming, desegregation (which sometimes brings about abandonment of tracking), and shrinking school sizes (which restricts possibilities for tracking). Tracking itself is increasingly being questioned as an effective way to deal with student heterogeneity. Studies of tracking find few achievement benefits (see Esposito, 1973; Good & Marshall, in press; Kulik & Kulik, 1982) except perhaps for gifted students (but see Slavin, 1983b for criticism of this research).

Rather than abandon programmed instruction, we began a project at the Johns Hopkins Center for Social Organization of Schools to attempt to resolve as many of the problems of programmed instruction as possible. We hoped to reap the achievement benefits of providing instruction appropriate to the needs and skills of individual students by reducing the time and management costs of programmed instruction and increasing the amount of direct instruction teachers could deliver in coordination with the individualized program. Our plan was to have the students themselves handle the routine management and checking required for the individualized program in small, heterogeneous teams, and to reward the teams based on the number and accuracy of units completed by all team members. In a decade of research on group-paced cooperative learning methods (see Slavin, 1980, 1983a), we had found that team incentives were effective in motivating students to help and encourage one another to achieve and thus were consistently effective in increasing student achievement. We now wished to apply the same principle to motivate students to help and encourage one another to do individualized units quickly and accurately.

We hypothesized that having student teams take responsibility for routine management and checking, helping one another with problems, and encouraging one another to achieve would free the teacher to provide direct instruction to small, homogeneous groups of students drawn from the heterogeneous teams. This instruction would integrate the homogeneous teaching groups with the individualized work by focusing on the concepts behind the algorithms that students were learning in their individualized work.

In addition to solving the problems of management and motivation in programmed instruction, we hoped to create a method that would take advantage of the socialization potential of cooperative learning. Previous studies of group-paced cooperative learning methods have consistently found positive effects on such outcomes as race relations and attitudes toward mainstreamed, academically handicapped students (see Slavin, 1980, 1983a). We expected that similar outcomes could be achieved in a method combining cooperative learning and individualized instruction.

Team Assisted Individualization

To solve the theoretical and practical problems of programmed instruction, we set out to create a method that would satisfy the following criteria:

--The teacher would be minimally involved in routine management and checking.

--The teacher would spend at least half of his or her time teaching small groups.

--Program operation would be so simple that students of any age could manage it.

--Students would be motivated to proceed rapidly and accurately through the materials, and could not do so by cheating or finding shortcuts.

--Many mastery checks would be provided so that students would rarely waste time on material they had already mastered or run into serious difficulties requiring teacher help. At each mastery checkpoint, alternative instructional activities and parallel tests would be provided.

--Students would be able to check one another's work, even when the checking student was behind the student being checked, and the checking procedure would be simple and not disruptive to the checker.

--The program would be inexpensive, flexible, and simple to learn for teachers and students, and would not require aides or team teachers.

--The program would, by having students work in cooperative, equal-status groups, establish conditions for positive attitudes toward mainstreamed, academically handicapped students and between students of different racial or ethnic background.

The Team-Assisted Individualization (TAI) program was developed to meet the above criteria. It was first piloted in a single class, then extensively revised, then studied in two full-scale but brief (8 and 10 weeks, respectively) field experiments, then revised again, then studied in a 24-week field experiment. The TAI program as applied in the field experiments consisted of the following components.

1. Teams. Students were assigned to four- to five-member teams by the project staff. Each team consisted of a mix of high, average, and low achievers as determined by a placement test boys and girls, and students of any ethnic groups in the class represented in the proportion they made up of the entire class. Students identified as receiving resource help for a learning problem were evenly distributed among the teams. Every eight weeks, students were reassigned to new teams by their teachers according to the same procedures.

2. Placement test. The students were pretested on mathematics operations at the beginning of the project and placed at the appropriate point in the individualized program based on their performance.

3. Curriculum materials. During the individualized portion of the TAI process, students worked on prepared curriculum materials covering addition, subtraction, multiplication, division, numeration, decimals, fractions, word problems, and introduction to algebra. These materials had the following subparts:

--An Instruction Sheet explaining the skill to be mastered and giving a step-by-step method of solving problems.

--Several Skillsheets, each consisting of twenty problems. Each skillsheet introduced a subskill that led to final mastery of the entire skill.

--A Checkout, which consisted of two parallel sets of ten items.

--A Final Test.

--Answer sheets for Skillsheets, Checkouts, and Final Tests.

4. Team Study Method. Following the placement test, students were given a starting point in the individualized mathematics units. They worked

on their units in their teams, following these steps:

--Students formed into pairs or triads within their teams. Each student located the unit he or she was working on and brought it to the team area. Each unit consisted of the Instruction Sheet, Skillsheets, and Checkout stapled together, and the Skillsheet Answer Sheets and Checkout Answer Sheets stapled together.

--Students exchanged Answer Sheets with partners within their teams.

--Each student read his or her Instruction Sheet, asking teammates or the teacher for help if necessary, and then began with the first Skillsheet in his or her unit.

--Each student worked the first four problems on his or her own Skillsheet and then had his or her partner check the answers against the Answer Sheet. If all four were correct, the student could immediately go on to the next Skillsheet. If any were wrong, the student had to try the next four problems, and so on until he or she got one block of four problems correct (asking teammates or the teacher for help if needed).

--When a student got four in a row on the last Skillsheet, he or she could take Checkout A, a ten-item quiz that resembled the last Skillsheet. On the Checkout, students worked alone until they were finished. When they were finished, a teammate scored the Checkout. If the student got eight or more items correct, the teammate signed the Checkout to indicate that the student was certified by the team to take the Final Test. If the student did <u>not</u> get eight correct, the teacher was called in to explain any problems the student was having. The teacher would then ask the student to work again on certain Skillsheet items. The student then took Checkout B, a second ten-item test comparable in content and difficulty to Checkout A. Otherwise, students skipped Checkout B and went straight to the Final Test. No student could take the Final Test until he or she had been passed by a teammate on a Checkout. When a student "checked out," he or she took the Checkout to a student monitor from a different team to get the appropriate Final Test. The student then completed the Final Test, and the monitor scored it. Two or three students served as monitors each day, rotating responsibility among the class every day.

5. Team Scores and Team Recognition. At the end of each week, the teacher computed a team score. This score was based on the average number of units covered by each team member, with extra points for perfect or near-perfect papers. Criteria were established for team performance. A high criterion was set for a team to be a "SUPERTEAM," a moderate criterion was established for a team to be a "GREATTEAM," and a minimum criterion was set for a team to be a "GOODTEAM." The teams meeting the "SUPERTEAM" and "GREATTEAM" criteria received attractive certificates.

6. Teaching Groups. Each day, the teacher worked with groups of students who were at about the same point in the curriculum for 5-15 minutes. In these sessions, the teacher prepared students for major concepts in upcoming units and went over any points with which students were having trouble. Teachers were instructed to emphasize concepts rather than algorithms in their instruction, as the individualized materials were considered adequate for teaching algorithms but not concepts.

Research on TAI

Three field experiments have been conducted to evaluate the effects of TAI on student achievement, attitudes, and behavior. The methods and results of these studies are described in the following sections.

Experiment 1

Experiment 1 (Slavin, Leavey, & Madden, in press; Slavin, Madden, & Leavey, 1982) was the first full-scale evaluation of TAI.

Experiment 1: Methods

Subjects and Design. The subjects in Experiment 1 were 504 students in grades 3, 4, and 5 in a middle-class suburban Maryland school district. Eighty percent of the students were white, 15% were black, and 5% were Asian (primarily Korean). Six percent of the students were receiving special education services at least one hour per day for a serious learning problem, and an additional 17% of the students were receiving other educational services, such as special reading or speech instruction. The students were in eighteen classes in six schools. The schools were randomly assigned to one of three conditions: Team Assisted Individualization (TAI), Individualized Instruction (II) without student teams, or Control. These treatments are described below. One third, fourth, and fifth grade class was then selected to participate in the study in each school. The three treatments were implemented for eight weeks in Spring, 1981.

Treatments

1. Team-Assisted Individualization (TAI). TAI was implemented as described above.

2. Individualized Instruction (II). The II group used the same curriculum materials and procedures as the TAI group with the following exceptions:

--Students worked individually, not in teams. They checked their own answer sheets for all Skillsheets and Checkouts. Criteria for going on (i.e., four correct for Skillsheets and eight out of ten for Checkouts) were the same as for TAI.

--Students did not receive team scores or certificates.

In all other respects, including curriculum organization, student monitors, teacher review sessions, and recordkeeping, the II treatment was identical to TAI.

3. Control. The control group used traditional methods for teaching mathematics, which consisted in every case of traditional texts and group-paced instruction, supplemented by small homogeneous teacher-directed math groups.

Measures

1. Mathematics Achievement. The Mathematics Computation subscale of the Comprehensive Test of Basic Skills (CTBS), Level 2, Form 2, was administered as a pre- and posttest of student mathematics achievement. The CTBS (rather than a curriculum-specific test) was used to be sure experimental and control classes would have equal opportunities to have their learning be registered on the test. No efforts were made to design the curriculum materials to correspond to the CTBS items.

2. Attitudes. Two eight-item attitude scales were given as pre- and posttests. The scales were Liking of Math Class (e.g., "This math class is the best part of my school day"), and Self-Concept in Math (e.g., "I'm proud of my math work in this class;" "I worry a lot when I have to take a math test"). For each item, students marked either YES!, yes, no, or NO!. Scores of negatively scored items were reversed, so that high scale scores indicated more positive attitudes.

3. Behavior Ratings. Teachers rated a sample of their students at pre- and posttesting on the School Social Behavior Rating Scale (SSBRS). The subsamples consisted of all students receiving some form of special service for a learning problem (e.g., reading or math resource, speech, or

special education), plus a random selection of six other students. The SSBRS consists of four scales designed to elicit teacher ratings of student behavioral and interpersonal problems. Students receiving special services were oversampled because they were seen as most likely to have behavioral and interpersonal problems that might be remedied by a cooperative-individualized treatment (see Slavin, Madden, and Leavey, 1982). The four scales were Classroom Behavior (e.g., "Does not attend to work), Self-Confidence (e.g., "Becomes easily upset by failures"), Friendships (e.g., "Has few or no friends"), and Negative Peer Behavior (e.g., "Fights with other students"). There were six items in the Negative Peer Behavior Scale and eight in the other three scales. A factor analysis using varimax rotation produced factor loadings consistent with a priori scales.

4. Peer Rating. A peer rating form was given at pre- and posttesting to assess acceptance and rejection of mainstreamed students. Each student was given a class list and was asked to mark each classmate as "a best friend" or "okay." Two measures were derived from this. The first was the number of nominations as "best friend" received by mainstreamed students. The second was the number of times mainstreamed students were listed neither as "best friends" nor as "okay," taken to be an indication of rejection. Only within-sex choices for boys were analyzed because there were very few mainstreamed girls in the sample.

Experiment 1: Results

The data were analyzed by means of multiple regressions, where for each dependent variable (posttest), the R^2 for a full model including pretest, grade, and treatment was tested against the R^2 for pretest and grade.

Insert Tables 1 & 2 Here

Table 1 shows the pre- and posttest means on all dependent variables taken on the full sample by treatment. Table 2 presents the results of the multiple regressions, including both the overall (3 x 1) results and each of the pairwise comparisons.

The results for the Comprehensive Test of Basic Skills (CTBS) indicated a marginally significant ($p < .07$) overall treatment effect, controlling for pretest and grade. The TAI group gained significantly more in achievement than the Control group, while the II group gained marginally ($p < .09$) more than the Control group. However, there were no significant differences between the TAI and II groups.

Results for the Liking of Math scale indicated a signficant overall treatment effect, as well as significant differences between TAI and Control and between II and Control, with both experimental groups scoring higher than the control group, controlling for pretest and grade. There were no differences between TAI and II. Overall treatment effects were also found for Self-Concept in Math. TAI significantly exceeded Control on this variable while II marginally ($p < .08$) exceeded the Control group.

Statistically significant overall treatment effects beyond the .001 level were found for all four behavioral rating scales (see Tables 1 and 2). For Class Behavior, TAI students were rated as having significantly fewer problems, controlling for pretest and grade, than either Control students or II students, but there were no differences between II and Control. On Self-Confidence, the Control group was rated as having more problems than either TAI students or II students. The TAI group had fewer problems reported than the II group. The Control classes were also scored as having more friendship problems than either TAI classes or II classes, but there were no differences between TAI and II. The same pattern of effects was seen for ratings of Negative Peer Behavior--more problems were reported in the Control classes than in the TAI or II classes, but there were no differences between TAI and II.

Insert Tables 3 & 4 Here

Tables 3 and 4 summarize the results of analyses for the mainstreamed subsample (from Slavin, Madden, & Leavey, 1982). Analyses of covariance indicate that TAI students exceeded control students on both sociometric measures (i.e., they gained more "best friends" nominations and were less often rejected). TAI students were also reported to have fewer problems than control students on all four behavior rating scales, and were higher in liking of math class. Interestingly, the same pattern of results was found for the comparison of II and Control treatments, with the exception of the Classroom Behavior scale, on which there were no differences. TAI students exceded II students only on the Classroom Behavior and Self-Confidence ratings, and on the Self-Concept in Math questionnaire scale.

Experiment 2

Experiment 2 was conducted primarily as a replication of the TAI-Control comparison studied in Experiment 1.

Experiment 2: Methods

Subjects and Design. The subjects in Experiment 2 were 375 students in grades 4, 5, and 6 in another suburban Maryland school district. Fifty-five percent of the students were white, 43% were black, and 2% were Asian. Four percent of the students were receiving special education services for a serious learning problem at least one hour per day, and an additional 23% of the students were receiving other special educational services, such as special reading or speech instruction. Four schools were involved in the study: two TAI schools were matched with two Control schools.

One TAI and one Control school were primarily middle- to lower-class in student population; one TAI and one Control school were primarily lower class. A total of ten TAI and six Control classes participated in the study.

Treatments. Experiment 2 compared TAI to Control methods (as described for Experiment 1) for ten weeks in Spring, 1981.

Measures. The achievement, attitude, and behavioral rating measures were the same as in Experiment 1.

Experiment 2: Results

The data were analyzed exactly as in Experiment 1, using multiple regressions testing the R^2 for a full model including treatment to that for a restricted model including only pretest and grade.

Insert Tables 5 & 6 Here

Table 5 shows the pre- and posttest means by treatment, and Table 6 presents the results of the multiple regressions.

The results for the CTBS closely mirror the TAI vs. Control comparison in Experiment 1. The TAI students scored significantly higher than Control students, controlling for pretest and grade. However, there were no significant differences on the Liking of Math Class or Self-Concept in Math scales. Controlling for pretests and grade, the TAI teachers reported significantly fewer problems than the Control teachers with regard to Self-Confidence and Friendships, but there were no differences seen on Classroom Behavior or Negative Peer Behavior.

Thus, while the achievement results of Experiment 2 confirm the TAI vs. Control comparison in Experiment 1, the strong attitude effects were not replicated, and the behavioral rating results of Experiment 1 were replicated only for Self-Confidence and Friendship Behaviors.

Experiment 3

Experiment 3 was conducted to assess the achievement effects of TAI over a longer period than in Experiments 1 and 2, to rule out the possibility that the positive effects found in the earlier experiments were due to short-lasting Hawthorne effects, to establish the usefulness of TAI as the primary means of delivering mathematics instruction, and to study the effects of TAI on the Mathematics Concepts and Applications scale of the CTBS as well as on the Mathematics Computations scale used in the earlier studies.

Experiment 3: Methods

Subjects and Design. The subjects in Experiment 3 were 1317 students in grades 3, 4, and 5 in the same middle-class suburban school district that participated in Experiment 1. Seven hundred students in 31 classes in four schools were assigned to use TAI, and 617 students in 30 classes in three similar schools matched on grade-level, district-administered California Achievement Test scores and type of neighborhood, served as the control group. The treatments were administered over a 24-week period from December, 1981, to May, 1982.

Measures. The only measures used were the Math Computations and Math Concepts and Applications scales of the CTBS. Students in grades 3-4 took Level 2, Form S of the CTBS, while those in grade 5 took Level H, Form U. Scores from corresponding scales of the California Achievement Test (CAT), given by the district in the fall of the third and fifth grades, served as covariates to adjust for any initial differences in achievement level (none were statistically significant) and to increase statistical power. Thus, for third and fifth graders the CAT scores were recent, but for fourth graders, fall third grade scores had to be used.

Experiment 3: Results

The data were analyzed by means of analyses of covariance. For analyses involving the CTBS Mathematics Computations Scale, CAT Mathematics Computations scores were used as the covariate; for CTBS Concepts and Applications, the corresponding CAT scores were used as the covariate. Analyses were conducted separately for each grade level. Also, an overall analysis was conducted by changing all scores to z-scores, adjusting posttest scores for covariates, and then conducting an analysis of variance on the residualized scores.

Table 7 About Here

The results are summarized in Table 7. Although all analyses were conducted using raw scores, Table 7 presents grade equivalents for ease of interpretation of the different tests.

TAI classes gained more than control classes (controlling for CAT scores) on every test at every grade level, and the differences reached statistical significance for Mathematics Computations at grades 3 and 5 but not 4. There were significant differences at grade 4 and marginal ($p < .09$) differences at grade 5 for Mathematics Concepts and Applications. In the overall analyses, the TAI classes significantly exceded control classes on both tests ($p < .001$).

Discussion

The results of the three field experiments evaluating Team-Assisted Individualization (TAI) clearly indicate that this method increases students' mathematics achievement more than traditional instructional methods. The TAI students gained more than their control counterparts on every achievement measure in every study, although the differences were not statistically significant on some subscales at some grade levels in Experiment 3. Experiment 3 demonstrated that TAI could be used over an extended time period (most of a school year) as the primary means of mathematics instruction.

In operation, TAI satisfied most of the criteria outlined earlier in this paper. In all three studies, students handled the routine maintenance and checking functions--in fact, their abilities to check partners, route themselves, record scores, and serve as monitors exceeded our initial expectations. The team reward system did seem to be very motivating and students greatly enjoyed both the program itself and making progress in it. Several teachers reported difficulty getting students to go to the next class; many students asked to do math all day.

One criterion that was only partially met was that teachers would be able to spend at least half of their time teaching small groups. In the three experiments reported here, most teachers worked mostly with individuals rather than small groups. We felt that this provided students with inadequate direct instructional time. In current applications of TAI, we have changed the procedure to make teaching groups easier to manage and have emphasized teaching groups more in teacher training. Most teachers who use TAI now do spend at least half of their class time teaching small groups of students. The effects of this will be known when the results of the current year's studies are analyzed.

Teachers have responded very favorably to TAI. Approximately 80% of all teachers who used TAI in the experimental studies continued to do so in the following school year.

One important theoretical issue is posed by the results of Experiment 1. In that study, the use of the individualized materials and all procedures except the cooperative teams increased student achievement (as compared to control students) almost as much as the full TAI program. Besides the materials themselves, this individualized instruction (II) treatment retained the student-managed aspect of TAI, including student monitors and self-routing, freeing the teacher to work with individuals and small groups, as in TAI. This result suggests that the cooperative teams may not be essential to TAI, but that the positive achievement effects seen for TAI are due either to student management of an individualized program or to the particular individualized materials themselves. However, Experiment 1 lasted only eight weeks; it is possible that over a longer period, the cooperative incentives and peer interaction would be needed to maintain student interest and motivation. A longer study comparing TAI with and without cooperative incentives is currently being planned.

The results of Experiment 1 for the mainstreamed subsample indicate that TAI can have a strong positive effect on the social acceptance and behavior of academically handicapped students. The sociometric findings mirror effects of group-paced cooperative learning methods (see Madden & Slavin, 1982). The behavioral rating effects are particularly dramatic. All academically handicapped students were rated as much worse in behavior than their non-handicapped classmates at the beginning of the study. By the end, ratings of academically handicapped students in the TAI classes were nearly identical to ratings of non-handicapped students in the control classes.

However, on most of the sociometric and behavioral rating measures, the II group performed almost as well as TAI group. This was even more surprising than the parallel finding for achievement. Meece and Wang (1982) also found positive effects of an individualized program without cooperative groups on acceptance of academically handicapped students. Slavin, Madden, and Leavey (1982) and Madden and Slavin (1982) discuss these findings and suggest that we may have underestimated the social benefits of individualized instruction. The II condition did not contain the cooperative work groups hypothesized to be the principle factor explaining the success of cooperative learning methods in improving relationships among diverse students (see Slavin & Hansell, in press). However, it does have other features that should have similar effects, particularly as regards acceptance of academically handicapped students. First it removes (or certainly reduces) individual competition between students. Non-competition has been found to reduce the degree to which students form a "pecking order" based on perceived intelligence, a characteristic of the traditional competitive class (see Ames, Ames, & Felker, 1977). Second, in the context of individualized instruction, it may be difficult or impossible to pick out the academically handicapped students. They are engaging in activities similar to those of their classmates, and are likely to experience success as they work on materials appropriate to their needs. This may make it possible for mainstreamed students to blend in behaviorally with their non-handicapped classmates to a degree that would be unusual in a traditional classroom, where these students must either be set apart to receive different stigmatizing tasks, or must often experience public failure (see Madden & Slavin, 1982). Finally, students are allowed to interact in individualized instruction, and the amount of interaction may be enough to create the positive social effects characteristic of cooperative learning methods.

Two recent studies (Oishi, Slavin, & Madden, 1983; Oishi, 1983) have investigated the effects of TAI on race relations. Both studies found that TAI improved attitudes and friendships among black and white students in Baltimore classrooms. Interestingly, the effects were stronger for decreasing negative attitudes than for increasing positive ones (although both outcomes were found). However, our experience implementing TAI in Baltimore elementary schools makes us cautious in recommending this method for use in low-achieving urban settings. In most of the classes involved in these studies, neither students nor teachers appeared to be able to handle the increased responsibility and autonomy given to students in TAI. High concentrations of students with serious reading problems and behavior problems made the program very difficult to implement. Preliminary analyses of achievement data from these studies indicate that TAI students learned no more (or less) than control students. On the other hand, research currently underway in inner-city Wilmington, Delaware schools indicates that TAI can be implemented well in urban settings. Wilmington has an extensive metropolitan desegregation plan that mixes students of quite diverse social class backgrounds in every class, avoiding the concentrations of low achievers seen in many of the Baltimore City classes. Work directed at making TAI more effective in low-achieving inner-city schools will continue.

Research on TAI is currently at an intermediate stage. The basic achievement effects of the program have been demonstrated in three field experiments and a number of positive social and attitudinal effects have been found. Research and development are continuing in order to improve the program and program outcomes, to explore effects other than achievement, and to resolve remaining theoretical and practical issues raised by the earlier experiments. However, we can tentatively conclude at this point that we were correct in our initial assumption: when the problems of management, motivation, and direct teaching that characterized previous programmed instruction are solved, the benefits of providing instruction appropriate to students' individual needs can finally be realized.

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Table 1

Means and Standard Deviations of
Achievement, Attitude, and Behavioral Rating
Variables by Treatment, Experiment 1

		TAI		II		Control	
		X	(S.D.)	X	(S.D.)	X	(S.D.)
CTBS Achievement	Pre	30.18	(10.08)	28.51	(11.59)	29.25	(11.27)
	Post	33.12	(9.43)	31.45	(11.31)	31.02	(11.86)
	N	138		148		148	
Liking of Math Class	Pre	24.37	(6.23)	25.02	(5.09)	23.23	(5.07)
	Post	25.09	(6.19)	25.51	(4.35)	21.93	(5.75)
	N	147		150		154	
Self-Concept in Math	Pre	24.87	(4.13)	24.23	(4.89)	24.56	(4.16)
	Post	25.80	(4.23)	24.97	(4.42)	24.40	(4.72)
	N	145		150		153	
Behavior Rating* Classroom Behavior	Pre	5.07	(4.85)	4.35	(5.37)	4.81	(5.88)
	Post	2.93	(3.43)	5.26	(7.85)	5.41	(5.85)
	N	58		68		83	
Behavior Rating* Self-Confidence	Pre	3.97	(3.76)	4.12	(5.32)	2.64	(3.55)
	Post	1.90	(2.80)	3.31	(5.05)	3.78	(4.57)
	N	58		67		83	
Behavior Rating* Friendships	Pre	1.95	(3.29)	4.46	(7.19)	2.00	(3.32)
	Post	1.57	(3.89)	2.79	(5.48)	3.17	(4.08)
	N	58		67		83	
Behavior Rating* Negative Peer Behavior	Pre	2.00	(3.13)	2.13	(4.08)	1.82	(3.00)
	Post	0.94	(1.94)	1.16	(2.58)	2.87	(3.76)
	N	49		67		83	

*For the behavioral ratings, high scores indicate more problems reported.

From Slavin, Leavey, & Madden, in press

Table 2

Results of Multiple Regressions, Experiment 1

	R^2 Total	R^2 Inc	F	d.f.	p<
CTBS					
Overall	.752	.003	2.76	2,431	.07
TAI vs Control	.769	.004	5.39	1,284	.03
TAI vs II	.721	.000	<1	1,284	n.s.
II vs Control	.766	.002	2.90	1.294	.09
Liking of Math Class					
Overall	.327	.035	11.66	2,448	.001
TAI vs Control	.360	.035	16.37	1,299	.001
TAI vs II	.275	.000	<1	1,295	n.s.
II vs Control	.312	.004	19.50	1,302	.001
Self-Concept in Math					
Overall	.410	.011	4.13	2,445	.01
TAI vs Control	.442	.014	7.28	1,296	.01
TAI vs II	.382	.003	1.28	1,293	n.s.
II vs Control	.406	.006	3.21	1,301	.08
Behavior Rating: Classroom Behavior					
Overall	.600	.041	10.43	2,204	.001
TAI vs Control	.672	.066	27.55	1,137	.001
TAI vs II	.471	.049	11.25	1,122	.001
II vs Control	.609	.000	<1	1,147	n.s.
Behavior Rating: Self-Confidence					
Overall	.536	.071	15.52	2,203	.001
TAI vs Control	.577	.118	38.25	1,137	.001
TAI vs II	.478	.024	5.51	1,121	.03
II vs Control	.571	.032	10.88	1,146	.001
Behavior Rating: Friendships					
Overall	.549	.040	9.10	2,203	.001
TAI vs Control	.595	.036	12.15	1.137	.001
TAI vs II	.541	.001	<1	1,121	n.s.
II vs Control	.549	.044	14.24	1,146	.001
Behavior Rating: Negative Peer Behavior					
Overall	.507	.075	20.80	2,194	.001
TAI vs Control	.526	.105	28.30	1,128	.001
TAI vs II	.405	.002	<1	1,112	n.s.
II vs Control	.561	.088	29.24	1,146	.001

From Slavin, Leavey, & Madden, in press.

Table 3

Means and Standard Deviations of Sociometric, Behavior Rating, Achievement, and Attitude Variables by Treatment, Mainstreamed Subsample, Experiment 1

		TAI		MO		Control	
		X	S.D.	X	S.D.	X	S.D.
"Best Friends"	Pre	5.86	3.21	4.34	3.68	4.54	2.84
	Post	6.04	3.02	4.61	3.66	4.00	2.08
	N	22		18		23	
"Rejections"	Pre	2.85	2.37	4.52	2.88	4.22	2.92
	Post	2.49	2.43	3.60	2.72	4.77	2.65
	N	22		18		23	
Behavior Rating: Classroom Behavior	Pre	7.48	5.47	6.06	7.20	7.33	6.85
	Post	3.84	2.70	8.29	9.77	8.35	6.42
	N	25		34		40	
Behavior Rating: Self-Confidence	Pre.	6.00	4.14	7.07	6.51	3.77	4.26
	Post	2.84	3.20	6.17	6.40	5.10	5.18
	N	25		29		40	
Behavior Rating: Friendships	Pre	2.88	3.89	5.71	7.90	2.70	3.67
	Post	1.80	3.91	3.26	4.66	4.20	4.18
	N	25		34		40	
Behavior Rating: Negative Peer Behavior	Pre	2.88	3.46	3.00	5.20	2.70	3.65
	Post	1.17	2.60	1.62	3.11	4.15	4.20
	N	18		34		40	
CTBS	Pre	27.6	12.1	22.8	10.3	24.9	11.5
	Post	27.2	12.3	25.3	11.6	25.4	13.0
	N	22		36		40	
Liking of Math Class	Pre	14.2	5.25	14.4	5.17	16.3	4.34
	Post	14.4	5.69	14.9	6.05	18.1	5.52
	N	27		37		39	
Self-Concept in Math	Pre	16.1	4.57	15.8	5.44	16.6	3.54
	Post	14.7	4.78	16.5	5.29	15.8	3.38
	N	27		37		39	

From Slavin, Madden, & Leavey, 1982.

Table 4

Results of Analvses of Covariance, Mainstreamed Subsample, Experiment 1

	F	d.f.	p <	Direction
"Best Friends"				
Overall	2.98	2,58	.06	
TAI vs. Control	5.91	1,41	.02	TAI > C
TAI vs. MO	<1	1,36	n.s.	
MO vs. Control	4.31	1,37	.04	MO > C
"Rejections"				
Overall	4.55	2,58	02	
TAI vs. Control	6.36	1,41	02	TAI > C
TAI vs. MO	1	1.36	n.s.	
MO vs. Control	5.32	1,37	.03	MO > C
Behavior Ratings: Classroom Behavior				
Overall	8.87	2,94	.01	
TAI vs. Control	28.10	1,61	.001	TAI > C
TAI vs. MO	10.37	1,55	.002	TAI > C
MO vs. Control	<1	1,70	n.s.	
Behavior Ratings: Self-Confidence				
Overall	8.56	2,89	.001	
TAI vs. Control	31.87	1,61	.001	TAI > C
TAI vs. MO	5.65	1,50	.03	TAI > MO
MO vs. Control	3.09	1,65	.09	MO > C
Behavior Ratings: Friendships				
Overall	7.97	2,94	.001	
TAI vs. Control	14.82	1,61	.001	TAI > C
TAI vs. MO	<1	1,55	n.s.	
MO vs. Control	12.66	1,70	.001	MO > C
Behavior Ratings: Negative Peer Behavior				
Overall	17.09	2,87	.001	
TAI vs. Control	22.15	1,54	.001	TAI > C
TAI vs. MO	<1	1, 48	n.s.	
MO vs. Control	32.70	1,70	.001	MO > C
CTBS				
Overall	1.44	2,93	n.s.	
TAI vs. Control	<1	1,58	n.s.	
TAI vs. MO	2.24	1,54	n.s.	
MO vs. Control	1.54	1,72	n.s	
Liking of Math Class				
Overall	2.66	2,98	.08	
TAI vs. Control	3.69	1,62	.06	TAI > C
TAI vs. MO	<1	1,60	n.s.	
MO vs. Control	3.40	1,72	.07	MO > C
Self-Concept in Math				
Overall	2.45	2,98	.10	
TAI vs. Control	1.10	1,62	n.s.	
TAI vs. MO	3.67	1,60	.06	TAI > MO
MO vs. Control	1.79	1,72	n.s.	

From Slavin, Madden, & Leavey, 1982.

Table 5

Means and Standard Deviations of
Achievement, Attitude, and Behavioral Rating
Variables by Treatment, Experiment 2

		TAI X	TAI (S.D.)	Control X	Control (S.D.)
CTBS Achievement	Pre	28.50	(9.39)	27.12	(9.87)
	Post	30.84	(9.16)	28.40	(9.36)
	N	189		114	
Liking of Math Class	Pre	22.34	(5.98)	23.97	(5.97)
	Post	23.07	(6.28)	23.96	(6.03)
	N	[illegible]		113	
Self-Concept in Math	Pre	22.[illegible]	(4.61)	23.61	(4.75)
	Post	[illegible]	(4.82)	23.95	(4.69)
	N	192		113	
Behavior Rating*: Classroom Behavior	Pre	8.62	(9.09)	8.64	(6.03)
	Post	8.97	(9.55)	8.00	(7.52)
	N	107		74	
Behavior Rating*: Self-Confidence	Pre	3.88	(4.22)	4.67	(4.63)
	Post	3.66	(3.70)	5.25	(5.22)
	N	82		73	
Behavior Rating*: Friendships	Pre	2.32	(3.96)	3.23	(4.56)
	Post	1.81	(3.44)	3.92	(5.47)
	N	81		64	
Behavior Rating*: Negative Peer	Pre	3.83	(5.71)	3.92	(4.43)
	Post	3.64	(5.87)	4.60	(5.35)
	N	107		73	

*For the behavioral ratings, high scores indicate more problems reported.

From Slavin, Leavey, & Madden, in press.

Table 6

Results of Multiple Regressions, Experiment 2

	R^2 Total	R^2 Inc	F	d.f.	p <
CTBS	.602	.006	4.70	1,299	.03
Liking of Math Class	.307	.000	< 1	1,301	n.s.
Self-Concept in Math	.376	.004	1.86	1,301	n.s.
Behavioral Rating: Classroom Behavior	.633	.004	1.72	1,177	n.s.
Behavioral Rating: Self-Confidence	.567	.018	6.27	1,151	.02
Behavioral Rating: Friendships	.545	.023	7.07	1,141	.01
Behavioral Rating: Negative Peer Behavior	.608	.006	2.67	1,176	n.s.

From Slavin, Leavey, & Madden, in press.

Table 7
Mean CTBS Scores in Grade Equivalents and Results on Analyses of Covariance, Experiment 3

	TAI	Control	F	p <
Grade 3-Comp.				
Pre (Gr. 3 CAT)	3.85	3.69		
Post (CTBS II)	4.88	4.61	5.81	.02
N	246	204		
Grade 3-C & A				
Pre	4.48	4.35		
Post	5.35	5.06	1.86	NS
N	245	206		
Grade 4-Comp				
Pre (Gr. 3CAT)	3.71	3.39		
Post (CTBS II)	5.71	5.37	<1	NS
N	219	162		
Grade 4-C & A				
Pre	4.16	4.00		
Post	6.63	5.97	10.80	.001
N	217	164		
Grade 5-Comp.				
Pre (Gr. 3 CAT)	6.15	6.26		
Post (CTBS H)	7.49	7.27	19.61	.001
N	239	247		
Grade 5-C & A				
Pre	6.88	6.68		
Post	8.02	7.65	2.86	.09
N	238	247		
Overall-Comp				
Pre	4.59	4.65		
Post	6.02	5.88	13.12	.001
N	704	613		
Overall-C & A				
Pre	5.20	5.19		
Post	6.49	6.34	13.61	.001
N	700	617		

From Slavin, Leavey, & Madden, 1983.