Can Instructional Variables Be Combined Effectively to Enhance Learning Achievement?

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Abstract: The purpose of this study was to explore an approach to group instructlon whereby alterable variables or instructional strategies are combined, in an attempt to achieve the effects associated with one-to-one tutoring (two standard deviations better than group instruction). The design of the project followed principles of instructional systems technology, and incorporated three Instructional strategies with known effect sizes: cooperative learning (Effect size = 80). enhanced student classroom participation (ES = 1.0), and advance organrzers (ES = .20). Cognitive, affective and sociometric measures were used to assess the outcomes of the combined treatments, compared to a control group which received conventional lecture-based instruction. Analysis of the data revealed that the approach of combining the three instructional strategies did not result in an effect size of two sigmas. The approach did, however, improve the cognitive achievement of low-aptitude learners, and did not adversely affect the cognitive achievement of middle- and high-aptitude learners. The combined instructional strategies were also found to positively influence students' attitudes toward cooperative learning, and heightened social interaction within the classroom.

INTRODUCTION

Can instructional strategies be combined in higher education courses to produce methods of group instruction which are as effective as one-to-one tutoring? Over the past eight years, a small group of research endeavors have been directed towards answering this question at the primary and secondary school levels. The results of these experiments seem to suggest that the combination of certain strategies may indeed enhance group instruction, so that it becomes as effective in promoting cognitive gains as one-to-one tutoring (Bloom, 1984; Leyton, 1983; Nordin, 1981; Tenenbaum, 1982,1986). Exposed to maximally effective instructional conditions in which instructional variables have been combined, low aptitude students have achieved final cognitive scores surpassing those of high aptitude students under conventional group instruction.

The educational implications of these findings are extremely important. If they can be generalized, practical methods of group instruction may emerge which can be widely applied with little more cost and time than conventional instruction. A change may also result in presently held notions about human potential for learning. Due to the comparatively small number of studies that have thus far been conducted in this area, however, the question of whether or not the impressive results obtained in the lower grades can be replicated in higher education remains, as yet, unanswered. Moreover, little wisdom has yet emerged as to which two or three strategies can best be combined (Bloom, personal communication, April, 1988). It is these issues that the present study attempts to explore.

THE TWO SIGMA (σ) EFFECT

In educational technology research the ultimate question is often how to provide a specific learner or group of learners, with the best possible instruction, so as to maximize the amount and the quality of the resultant learning. One suggested solution which appears to be highly effective is one-to-one tutoring (Lippitt & Lippitt, 1968), a method which involves a teacher or teacher's aide working directly on a body of information, using a strategy specifically developed to meet the individual learning needs of that student. Under these conditions, feedback from tutor to student is constant, immediate and accurately responsive to the needs of the student. Studies by Anania (1983) and Burke (1983) have demonstrated overwhelming support for the superiority of tutorial over group instruction. After just three weeks, initially similar students were observed to exhibit dramatic differences in their capabilities in the subject being taught and their attitudes toward it.

Of interest here were the differences in final achievement under the conditions of tutorial instruction, mastery learning and group instruction. The average tutored student was at a level above approximately 98% of the conventionally instructed students, while the average student under mastery learning attained final achievement above approximately 84% of the students in conventional group instruction. In other words, tutored students achieved two standard deviations (two sigmas) above the conventionally instructed control group; mastery students achieved one standard deviation. Moreover, these results held regardless of the level of learning objective.

While one-to-one tutoring is clearly an effective method of instruction, it is too costly to be considered a ubiquitous instructional strategy. For this reason, it has not been widely accepted and applied in schools and universities, except in special circumstances. Instead, more economical methods have been proposed to deal with differences in the learning needs of individuals. These methods, known collectively as "individualized instruction," include Glaser's Individually Prescribed Instruction (IPI), Computer Aided Instruction (CAI), Keller's Personalized System of Instruction (PSI), and the various forms of

Mastery Learningproposed by Carroll (1963), Bloom (1968) and Block (1971). Recently, intelligent tutoring has emerged in the literature of educational computing, for essentially the same purpose – to mimic the characteristics that render one-to-one tutoring educationally effective. None of these, however, has achieved the high level of effectiveness – the "two sigma effect" – associated with one-to-one human tutoring.

Work by Bloom (1980) and others to achieve the "two sigma effect" has taken the direction of combining what he refers to as alterable variables (i.e., instructional strategies which can be applied by the teacher or instructional designer), for the purpose of affecting different "objects" of the instructional process. These objects include: a) the learner; b) the instructional materials; c) the home environment or peer group; and d) the teacher. Table 1 (see following page), adapted by Bloom (1984) from Walberg (1984), summarizes the effect sizes (ES) of selected alterable variables and shows Bloom's classification of the object that they influence or change. Further, Bloom speculates that it might be possible to combine certain variables so that their effect is additive. In theory, this could yield enhanced learning, which approaches the "two sigma effect" associated with tutorial instruction. For example, the separate effects of mastery learning (ES = 1.0) and another variable, such as cues and explanations (ES = l.O), might yield, when combined, an effect size of 2.0.

Combining Instructional Strategies

To date, the literature addressing the notion of combining instructional strategies is, in Bloom's own words, "still very crude" (B. S. Bloom, personal communication, April, 1988). Indeed, there exists a small number of studies which have thus far attempted to combine instructional strategies in an effort to devise methods of group instruction as effective as one-to-one tutoring. The following is a brief description of these studies.

> Nordin (1981) — sixth grade subjects in rural Malaysia were exposed to either: a) enhanced cues (ES = 1.0; change object = teacher), b) enhanced student classroom participation (ES = 1.0; change object = learner), c) enhanced cues + participation, d) feedback-corrective (mastery), ore) traditional group instruction. Results indicated that the average student in the enhanced cues + participation condition outperformed the control condition by 1.5 sigma.
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> Tenenbaum (1982,1986) -sixth and ninth grade subjects studying algebra and science were exposed to either: a) enhanced cues, participation, reinforcement and feedback-corrective procedure (a maximal instructional condition), conventional group instruction (a minimal instructional condition), or c) a mastery learning condition (lying between the two extremes). Results indicated an advantage of 1.7 sigma for the combined treatment over the control condition.

Table 1
Effect of Selected Alterable Variables on Student Achievement

Object of change[1]	Variable	Effect size[2]	Percentile equivalent[3]
D	Tutorial instruction	2.00	98
D	Reinforcement	1.20	
A	Feedback-corrective (Mastery Learning)	1.00	84
D	Cues and explanations	1.00	
A/D	Student classroom participation	1.00	
A	Student time on task	1.00	
A	Improved reading/study skill	1.00	
C	Cooperative learning	.80	79
D	Homework (graded)	.80	
D	Classroom morale	.60	73
A	Initial cognitive prerequisites	.60	
C	Home environment intervention	.50	69
D	Peer and cross-age remedial tutoring	.40	66
D	Homework (assigned)	.30	62
D	Higher order questions	.30	
D/B	New science & math curricula	.30	
D	Teacher expectancy	.30	
C	Peer group influence	.20	58
B	Advance organizers	.20	

Note: From Bloom, B. S. (1984) and Walberg, H. J. (1984).
[1] A = the learner; B = the instructional materials; C = the home environment or peer group; D = the teacher
[2] Effect size = $\mu_{experimental\ group} - \mu_{control\ group} / SD_{control}$
[3] Percentile equivalent = percentage of experimental distribution that exceeds the mean of the control distribution.

- Leyton (1983) — ninth grade subjects studying French as a Second Language and algebra were exposed to either: a) enhanced initial cognitive prerequisites (ES = .60; change object = learner) + mastery learning, b) conventional instruction, c) mastery learning, or d) conventional group instruction supplemented with enhanced cognitive prerequisites. Results indicated an that the mean of the prerequisites + mastery condition exceeded the control mean by 1.6 sigma.

- Mevarech (1985) — a) cooperative learning (ES = .80; change object = the home environment or peer group) + mastery learning (ES = 1.0; change object = learner), b) cooperative learning alone, c) mastery learning alone or d) traditional group instruction. Results indicated that the average student in the mastery learning condition outperformed the control condition by .5 sigma and the combined strategy condition performed at the .8 sigma level.

More or less, these studies have confirmed the underlying premise that alterable variables can be combined successfully to enhance learning. Of possibly greater interest is the fact that in some studies, lower achieving students (determined on the basis ofpretest results) were found to equal or outperform so called higher achieving students (Burke, 1983; Leyton, 1983; Tenenbaum, 1986).

In addition to determining whether the combining strategy works, it is also important to know the conditions under which it works. Several tentative "rules" have been devised to aid in selecting variables for combination. Bloom (1984) speculates that variables involving different objects of the change process (see Table 1) are more likely to produce additive results than variables involving the same object. In several studies this was used as a rule of thumb for selecting variables (Nordin, 1981; Mevarech, 1985; Tenenbaum, 1982, 1986). In another study (Leyton, 1983), a different approach was used – that variables implicating the same object be combined as long as they occur at different times in the teaching/learning process. From the limited results reported above it tentatively appears that both rules are appropriate.

QUESTIONS THAT REMAIN

Despite the impressive cognitive outcomes attained in the forgoing literature, there are several issues regarding the combination of instructional variables which remain unclear. First of all, it is not yet known whether the cumulative effect sizes obtained in the above studies can be replicated with older university-level students. Unfortunately, little help can be derived from the meta-analyses upon which the effect size estimates were based (Lysakowski & Walberg, 1981; Walberg, 1984) since the literature reflects the bias of almost exclusive samplingfrom elementary and secondary students. Thus, the extent to which the calculated effect sizes are representative of the results achievable in higher education is unknown.

Second, it remains to be determined how to go about choosing variables. Because not all variables in Table 1 have been investigated, the "rules" provided by Bloom (1984) are little more than suggestions at the present time. Here are some of the questions that remain regarding the appropriateness of various combinations: Are all variables equally combinable, or are some particularly good or bad matches? Since only variables with effect sizes of .5 or more have been investigated, how will variables with lower effect sizes perform? All but one study (Nordin, 1981) has used mastery learning as one of the constituents. Is mastery a necessary ingredient to achieve the "two sigma effect," or can other variables with high effect sizes, like cooperative learning, be applied successfully?

A final issue which, requires clarification in future research, concerns Bloom's classification of instructional variables into four distinct categories. Closer inspection of the variables listed in Table 1 raises the question whether the direct object of the change process for each variable is as absolute and exclusive as Bloom implies. For instance, cooperative learning may not only affect changes in the peer group, but also alter the role of both teacher and student in the instructional process. Even the materials may be implicated in designing cooperative learning sessions. Similarly, peer and cross-age remedial tutoring may be seen as involving dramatic changes in peer group relations, possibly to the same extent as it affects changes in the role of the teacher.

VARIABLES IN THIS STUDY

Three alterable variables from Table 1 were selected for inclusion in the study. Cooperative Learning (ES = .80, object of change = peer group relations), Student Classroom Participation (ES = 1.0, object of change = the learner and teacher) and Advance Organizers (ES = .20, object of change = the instructional materials), when added together, equal the hypothetical effect size of one-to-onetutoring (ES =2.0). Following is a brief review of these variables considered separately.

Cooperative Learning

According to Johnson and Johnson (1983) there are three ways that instructional goals can be structured in the classroom: cooperatively, competitively and individually. The literature of cooperative learning, the strategy used in this study to affect peer group relations, suggests that through its use, a wide variety of academic and social outcomes may be achieved (Moskowitz, Malvin, Schaeffer & Schaps, 1985). The reported benefits of the approach include improved interpersonal relations (Blaney, Stephen, Rosenfield, Aronson & Sikes, 1977; DeVries & Slavin, 1978; Garibaldi, 1979) such as cross-ethnic relationships (Cook, 1978; Hansel1 & Slavin, 1981; Weigel, Wiser & Cook, 1975), cross-sex relationships (Slavin, 1985) and greater acceptance of handicapped students (Johnson & Johnson, 1983; Johnson, Johnson & Rynders, 1981; Madden & Slavin, 1983). Cooperative learning has also been found to increase students' attitudes toward themselves (Blaney, et al., 1977), and their peers, their teachers and their schools (Duin, 1984; Sharan, 1980). There is less agreement about the benefits of cooperative learning for improving cognitive performance of students, however. Several meta-analyses have asserted the benefits of cooperative learning for all but the most concrete, repetitive tasks (Johnson & Johnson, 1974; Johnson, Maruyama, Johnson, Nelson & Skon, 1981; Sharan, 1980). However, cognitive achievement results reported in several studies have indicated the possible presence of aptitude x treatment interactions. These have been as likely to favor high ability learners (Hulten & DeVries, 1976; Webb & Kenderski, 1982) as low ability learners

(Edwards, DeVries & Snyder, 1972; Slavin & Oickle, 1981). Some studies have noted the presence of a curvilinear interaction whereby high and low learners profit from the treatment, but middle ability learners perform best on their own (Peterson, Janicki & Swing, 1981; Webb, 1977).

Only a small proportion of the studies of cooperative learning have been performed in college and university classrooms. These studies (Fraser, Beaman, Diener & Kelem, 1977; Haines & McKeachie, 1967; McClintock & Sonquist, 1976; Smith, Johnson & Johnson, 1981; Cox, 1984; Duin, 1984; Hamilton, 1976) tend to indicate a positive influence for cooperative learning on the achievement and attitudes of older students.

The cooperative learning instructional strategy is actually made up of a variety of different methods. The most extensively researched methods are the Student Team Learning methods developed by DeVries, Slavin and Edwards (Slavin, 1980). These methods include Student Teams Achievement Divisions (STAD), Teams-Games-Tournament (TGT), Jigsaw II, and Team Assisted Individualization (TAD. Other methods include the original Jigsaw strategy, the Learning Together model, and the Group-Investigation model.

STAD, TGT and TAI are highly structured, and entail clearly specified group tasks and group rewards. Group Investigation and Learning Together, by contrast, grant greater autonomy to students, and have a less well specified reward structure. The original form of Jigsaw also does not include formal group rewards. Generally, the literature suggests that methods which employ specific group rewards, based on group members' individual learning performances, and which stress individual accountability, are more effective at promoting cognitive achievement than methods which do not (Slavin, 1983).

Student Classroom Participation

Lysakowski and Walberg (1982) define participation as, "the extent to which the student actively participates or engages in the learning process" (p. 560). In so far as this occurs within a classroom, it may be considered classroom participation. Elsewhere referred to as "active learning' (Bouton & Garth; Brothen, 1986) or "student involvement" (Mallor, Near & Sorcenelli, 1981), student participation typically involves the use of small learning groups, and requires students to work together on tasks in order to learn a prescribed set of concepts or skills. As students use their own resources and each other to work through the content to be learned, a process of active discovery takes place (Brothen, 1986).

The literature on student participation suggests that the technique may be applied effectively across a wide variety of learning situations. Ameta-analysis by Lysakowski & Walberg(1982) has shown the positive effects ofparticipation to be constant from elementary school through college, and across socio-economic levels, races, private and public schools, and community types. Bouton and Garth (1983) maintain that in order for student classroom participation to effectively influence learning, two major elements must be present: a) an active learning process, promoted by student conversation in groups; and b) instructor expertise and guidance through structured learning tasks. It is not sufficient to simply increase discussion or replace lectures with group work. Both elements – structured tasks and peer participation must be present.

Advance Organizers

The premise behind the application of advance organizers is that, "the learning and retention of unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant subsuming concepts (organizers)" (Ausubel, 1960, p. 267). There has been disagreement over the effectiveness of advance organizers in promoting learning compared with no advance organizer control conditions. Initial studies, as well as some reported recently (Ausubel & Youseff, 1963; Ausubel & Fitzgerald, 1961, 1962; Fitzgerald & Ausubel, 1963; Allen, 1969; Scandura & Wells, 1967; Grotelueschen & Sjogren, 1968; Levine & Loerinc, 1985; Krahn & Blanchaer, 1986; Green, 1986), have found advance organizers generally useful in promoting learning and retention over a variety of contents. However, several studies have found the opposite (Barron, 1971; Bauman, Glass & Harrington, 1969; Feller, 1973). Ameta-analysis of 135 advance organizer studies (Luiten, Ames & Akerson, 1980) found a mean effect size of .21 to be associated with the use of advance organizers.

The purpose of the present study was to assess the cognitive, affective and sociometric outcomes of a university-level unit of group instruction, developed by way of instructional systems design, and incorporating the three instructional strategies just reviewed: cooperative learning, enhanced student participation, and advance organizers. The extent to which this theoretically "maximal" mix of variables approximated the effectiveness of one-to-one tutoring was of primary concern. The study also sought to clarify three issues mentioned previously: a) the effectiveness of the technique with older students; b) the effectiveness of cooperative learning combined with other lower-order variables; and c) the use of variables other than mastery learning.

METHOD

Subjects

Subjects were 133 undergraduate students taking an educational psychology course in the Department of Education at Concordia University. They were predominantly female anglophones with a modal age of 19 years.

Design

The study may be characterized as apre-post non-equivalent control group design (Campbell & Stanley, 1963) -random assignment of subjects to treatments was impossible. There were two levels of treatment (i.e., the combined variables), taught by different instructors. A control group, taught by one of the two instructors, received conventional lecture-based instruction. The comparison between the conditions with a common instructor was of greatest interest, because it was in this comparison that instructor was held constant. The comparison between the two treatment conditions was of interest because it attempted to assess the differential results that might accrue from different instructors using the same procedure. This was an attempt to generalize the findings beyond a single instructor.

Materials

Instructional unit. A systematically designed instructional unit, incorporating cooperative learning, enhanced student classroom participation, and advance organizers, constituted the instruction for the treatment condition. The unit was developed according to the principles of instructional systems design, and addressed the issue of learning theories, the content normally covered during the first five weeks of the winter semester. The unit consisted of twelve and one-half hours of instruction, A series of lectures, covering the same course content, and based on the same instructional analysis as the treatment conditions, was developed by one of the two course instructors. The rationale for and the procedures used in designing the instructional treatments are described in the Procedures section of this article.

Prior achievement. Grades from the first term of this course were used to construct a measure of prior achievement. Expressed as a percentage, this score was calculated for each student based upon the combined scores on two exams and a term paper.

Cognitive measures. Subjects' cognitive knowledge of the content covered by the instructional unit was measured by way of a cognitive post-test, administered to both treatments and the control group. It consisted of 38 multiple-choice items, drawn from the content of the instructional unit.

Affective measure. A pencil-and-paper instrument assessing subjects' attitudes toward cooperative group work was administered to the treatment and control groups both prior to and following the five-week instructional period. The instrument consisted of 16 statements designed to assess the extent to which subjects agreed or disagreed, on a five-point scale, with commonly held notions concerning cooperative learning, group work and cooperation in general. The instrument was pilot tested and then modified, before it was presented to the target group.

Sociometric measure. Changes in social interaction among class members were assessed by way of a paper-and-pencil sociometric test, administered to the treatment groups only, both before and after exposure to the instructional treatments. The test was designed according to established sociometric principles, as defined by Northway (1967), and was used to determine the degree to which subjects in the two treatments were accepted by their groups. The instrument consisted of four questions which asked subjects to state with whom, among the members of the class, they preferred to associate for specific activities, and in particular situations. Based on subjects' responses, two scores were calculated: a "social acceptance score" and an "emotional expansion score." The former is based on the number of choices received by each individual on each criterion, while the latter represents the number of people chosen by each individual.

Procedure

Instructional unit. The instructional unit was designed according to a modified version of Dick and Carey's (1985) systems approach for designing instruction. Two additional steps were added – analysis of unit variables and a consideration of research and theories of learning. The steps in the models used in designing the instruction are as follows:

a) identify instructional goals;
b) conduct an instructional analysis;
c) identify entry behaviors and characteristics;
d) analyze unit variables;
e) write performance objectives;
f) develop criterion-referenced test items;
g) consider learning theory and research;
h) develop an instructional strategy;
i) develop and select instruction; and
j) design and conduct formative evaluation.

Formative evaluation was conducted in the following phases: a) expert review; b) one-to-one evaluation; and c) field evaluation.

The following section details the rationale for and steps employed in designing the combined learning treatments: cooperative learning, student classroom participation and advance organizers.

Cooperative learning. The specific cooperative learning method that was chosen for the purpose of the present study was Aronson's (1978) Jigsaw method. Originally designed to enhance performance of minority students in newly integrated, Texas public schools, the Jigsaw cooperative learning method involves the division of learning tasks among various groups of students (McDougall & Gimple, 1985).

Each group member was assigned a section of academic material to learn, and subsequently to teach group mates. Members from each group who were assigned, or chose, the same topic area, met in "expert groups," where they discussed and learned about their specific topic areas. Once they have became "experts" in their respective topics, students returned to their original groups, and took turns teaching their group mates what they had themselves learned. Individual students were then tested over the content for which they received individual grades.

Although mixed results have been reported for Jigsaw in terms of its effect on academic performance, self-esteem and attitudes toward school itz, et al., 1985), it was considered the most suitable cooperative learning method for use in this study because of its match with the narrative, factual information contained in the course, its ease of implementation by the course instructors, and its lack of group reward structure. The instructors felt more comfortable with individually-assigned, rather than group-assigned grades.

Student classroom participation. Participation during the classroom sessions was not specially designed but came as a by-product of the cooperative learning strategy. Since each student had the responsibility to both learn and subsequently teach certain blocks of material, a primarily learner-directed and discovery-oriented learning environment was created.

Advance organizers. At the beginning of each lesson, the instructor provided an advance organizer of the material to be covered in the lesson. Recall of previously learned information, relevant to the lesson in question, was stimulated at this point. Advance organizers were also provided to students during the group-directed activities (i.e., as part of the cooperative learning strategy) to pre-inform students of the tasks they were to accomplish and the material to be learned.

Administration of treatments. In all, five units ofinstruction were designed and implemented with subjects in the two combined treatments. At the same time, identical content was being delivered, via lecture, to subjects in the control condition. Each instructional session lasted approximately two and one-halfhours during which students in the treatment conditions engaged in a variety of teacher-led and student-led activities, The following is a sample lesson plan:

Lesson 4

Topic: Information processing

Objectives: By the end of the lesson, the students were expected to be able to define information processing, as well as name and explain the structures and control processes in the brain involved in information processing (according to the Atkinson-Shiffrin model). In addition, the students were expected to name and explain the various methods for improving learning and recall.

Summary of Activities:

1. Instructor delivers short introductory lecture about information processing.
2. Students take part in two memory activities, led by the instructor.
3. Instructor informs students of the historical context of information processing.
4. Instructor provides advance organizer of topics to be covered in information processing.

5. Students take part in cooperative activity in which they learn various different aspects of the Atkinson-Shiffrin model of information processing, and subsequently teach what they have learned to rest of class.
6. Students take part in the Jigsaw learning activity, employing self-instructional packages; in expert groups, learn strategies for improving memory and recall, and subsequently teach what they have learned to other group members.
7. Instructor provides summary of content covered, and answers students' questions.

Statistical analysis. Cognitive achievement data were analyzed using analysis of covariance. The cognitive post-test served as the dependent variable and the prior achievement measure served as the covariate. Analysis of covariance assumes that the within cells slope ($b_{S/A}$) for all treatments is a reasonable approximation (not different within chance) of the slopes for individual treatments (i.e., $b_{S/A\,i}$). As a result, homogeneity of regression was tested. The attitude data were analyzed by subjecting pre-test scores, for the 16-item inventory, to principle components analysis to locate blocks of items that were empirically related. Since PCA results in factors of correlated items that are orthogonal, related items by factor could be used as separate dependent variables. Multivariate analysis of covariance (with the pre-test serving as the covariate) was used to investigate the between-group hypothesis. The sociometric data were analyzed using the non-parametric sign test.

RESULTS

The results of analyses of three measures are reported here: results associated with cognitive outcomes of the experiment, results associated with affective outcomes and results of the sociometric measure.

Cognitive Outcomes

A test of prior achievement (henceforth referred to as pre-test) was used to measure learningup to the point of the administration of treatments and a post achievement test (post-test) measured achievement towards the course objectives after the treatments were administered. The post-test served as the dependent measure in the study and the pre-test was used as a covariate (See Table 2 for means and standard deviations), to remove otherwise unexplained variabiliity in subjects' achievement before the start of the experiment. The cognitive post-test scores were analyzed by way of one-way analysis of covariance. The covariate was found to be a significant predictor of post-test scores $F = 53.44$ (1, 127), $p < .001$. However, there were no significant differences among the levels of treatment, $F = (2,127) = 2.92$, $p > .05$.

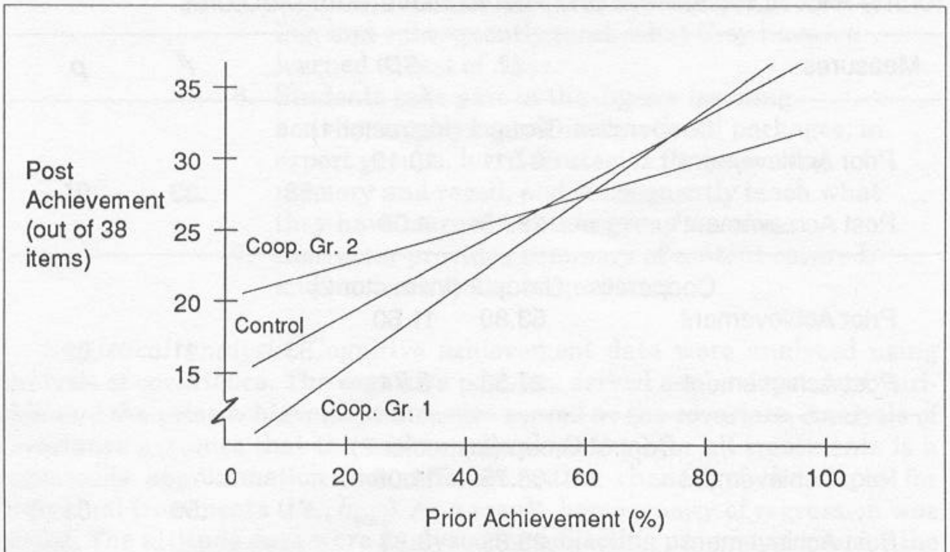
Table 2
Unadjusted Means, Standard Deviations, *r*, r^2 and *p*
for the Prior Achievement and Post Achievement Measures

Measures	*M*	*SD*	*r*	r^2	*p*
Cooperative Group 1 (Instructor 1)					
Prior Achievement[1]	**67.11**	**10.19**	**.58**	**.33**	**.01**
Post Achievement[2]	**28.13**	**4.06**			
Cooperative Group 2 (Instructor 2)					
Prior Achievement	**63.80**	**11.60**	**.33**	**.11**	**.02**
Post Achievement	**27.53**	**3.74**			
Control Group (Instructor 2)					
Prior Achievement	**68.75**	**11.05**	**.71**	**.50**	**.01**
Post Achievement	**29.88**	**3.23**			

Note: Cooperative Group 1, *n* = 47; Cooperative Group 2, *n* = 43; Control Group, n = 41,
[1] Prior achievement = % score based on combination of two exam scores plus a term paper.
[2] Post achievement = number of correct multiple choice items out of 38, administered at the end of the learning theories unit.

Further investigation of the interaction between the covariate and the individual treatments (i.e., sometimes called a test of homogeneity, a “slope test” or a test of parallelism) revealed a significant deviation from equal slopes for one of the three treatments, $F\ (1,\ 126) = 4.54$, $p = .04$. Since this test measures the divergence of individual treatment slopes from the other treatment slopes, a significant difference here indicates that for one group, the relationship between the pre-test and the post-test was different than for the other treatments. Figure 1 (see following page) shows this relationship among individual treatment regression lines. Correlation coefficients and associated statistics are shown in Table 2. These statistics indicate that for the Control Group, the pre-test and the post-test were highly correlated. For the Cooperative Group 1 a fairly high correlation was found and for Cooperative Group 2 a low correlation was found. A weak correlation between prior achievement and post achievement is predicted in several studies involving the combined instructional strategies (e.g., Burke, 1983; Tenenbaum, 1982). Under this condition, prior achievement becomes a less influential determinant of summative achievement than does the nature of the instruction. As a result, “lower” students are observed to perform better, while ‘higher” students continue to perform well.

Figure 1. Individual Treatment Regression Lines Illustrating Aptitude x Treatment Interaction.



Affective Outcomes: Cooperative Learning

Subjects' attitudes towards cooperative group work were analyzed in three steps – principle components analysis, multiple analysis of variance (MANCOVA) and discriminant functions analysis. The purpose was to uncover any between-group differences in students' attitudes that resulted from the various treatments. Since the instrument tapped different aspects of attitudes toward cooperative learning and group interaction, its items were not treated homogeneously, but reduced to separate sub-sets of like items. As a result of the possible presence of treatment effects in the post-test, the pre-test was used as the basis for establishing the presence of item sub-sets. Principle components analysis was conducted on the 16 pre-test items with subjects treated as a homogeneous sample.

The results of the principle components analysis revealed that 12 of the 16 items loaded highly on three factors (40% of the total variance was accounted for by these three factors). An interpretation of the three factors was carried out by attempting to associate conceptually homogeneous items in each separate factor. The first of the three factors appeared to address the pros and cons associated with group work (e.g., group grades are an unfair method of student evaluation), while the second concerned the practical aspects involved in the application of cooperative learning (e.g., group work enables more work to be accomplished in a short time). Finally, the third factor appeared to address, more generally, the notions of cooperation and competition (e.g., competition in the classroom motivates students to work harder).

Three attitudinal sub-tests were created by adding together post-test responses within each of the three factors (Factor 1 contained 5 items; Factor 2 contained 4 items; and Factor 3 contained 3 items) Between-group differences in post-test scores were then analyzed using MANCOVA, with the 12 items on the post-test broken into three sub-sets, serving as multiple dependent measures and the pre-test serving as the covariate. Amultivariate test of homogeneity ofregression indicated that the assumption ofparallel slopes was satisfied. Unadjusted means and standard deviations are provided in Table 3 (see following page).

The result of the MANCOVA revealed a significant main effect for treatments, $F(6,174) = 5.12$, $p < .05$. Inspection of the dimension reduction analysis in MANCOVA indicated that only one of the two potential vectors accounted for the majority of variance in group differences (99.78%), and so the three dependent measures were considered a multivariate set (i.e., univariate analysis was inappropriate).

Follow-up analyses of the multivariate treatment effects were conducted in discriminant functions analysis (Table 4 on the following page shows the results of these tests). Asignificant difference was found between the post-test multivariate means (i.e., group centroids) of Cooperative Group 2 and those of the Control Group. By examining the univariate post-test means in Table 3, one may conclude that, after treatment, subjects in the second cooperative group exhibited significantly higher attitudes towards cooperative group work than did their counterparts in the control condition. Significant differences were also found between the combined post-test means of the two cooperative groups and the Control Group.

Sociometric Outcomes

Two sociometric measures were analyzed: changes in sociometric status (i.e., social acceptance), and changes in subjects' emotional expansion. Differences in pre- and post-test scores on both measures were analyzed by way of a sign test (i.e., dependent test of change in behavior for nominal data). Subjects in both Cooperative Group 1 ($n = 48$) and Cooperative Group 2 ($n = 44$) exhibited significant increase in sociometric status, $C = 4.90$, $p < .05$ and $C = 6.40$, $p < .05$, respectively The number of "isolates" (i.e., people unchosen) dropped from 11 on the pre-test, to six on the post-test for Cooperative Group 1, and from 13 to six for Cooperative Group 2.

A similar increasing trend was found for the emotional expansion measure. Subjects in both groups exhibited significant gains in emotional expansion, $C = 13.76$, $p < .05$ for Cooperative Group 1 ($n = 33$), and $C = 19.60$, $p < .05$ for Cooperative Group 2 (n 32). From these results, it was concluded that exposure to the systematically designed instructional unit affected substantial gains in subjects' sociometric status and emotional expansion.

Table 3
Attitudes Towards Cooperative Group Work: Unadjusted Means and Standard Deviations

Group	Pre-test *M*	Pre-test *SD*	Post-test *M*	Post-test *SD*
		Factor 1		
Cooperative Group 1	15.20	3.54	14.69	4.06
Cooperative Group 2	15.91	2.95	17.12	2.72
Control Group	14.00	4.34	12.38	3.79
		Factor 2		
Cooperative Group 1	14.63	2.43	14.77	2.47
Cooperative Group 2	15.30	2.51	15.09	2.34
Control Group	14.47	2.38	14.34	2.15
		Factor 3		
Cooperative Group 1	11.34	1.57	11.86	1.59
Cooperative Group 2	11.91	1.28	12.24	1.31
Control Group	11.69	1.28	11.34	1.31

Note: Cooperative Group 1, n = 35; Cooperative Group 2, n = 33; Control Group, n = 32.

Table 4
Results of Discriminant Functions Follow-up Analysis on Attitudinal Data

Comparison	*df*	*F*	*p*
Coop. 1 vs. Coop. 2	6.61	1.74	.13
Coop. 1 vs. Control	6.60	1.23	.30
Coop. 2 vs. Control	6.58	5.31	.01
Coop. 1 + 2 vs. Control	6.93	3.27	.01

DISCUSSION

Cognitive Outcomes

The primary question being asked in the present study was whether students, exposed to the combined cooperative learning/student participation/ advance organizer instructional strategy, would achieve significantly different cognitive post-test scores from those obtained by unexposed students and whether these scores would approach the two sigma effect of tutorial instruction. Clearly, this did not occur. That is not to say, however, that the combined instructional strategy did not influence cognitive learning whatsoever. While high, medium and low learners in Cooperative Group 1 and the Control Group performed at a level on the cognitive post-test that approximated their own performance on the prior achievement measure, lower ability subjects in the Cooperative Group 2 were observed to perform nearly as well as middle ability subjects. This means that the instructional treatment benefited the lower learners in the second treatment group. The weak correlation detected between prior achievement and post-test scores for this group, suggests that, in this group, the experimental treatment exerted a stronger influence on summative achievement than did student aptitude. There is evidence of this aptitude x treatment interaction in prior studies involving combined treatments (Burke, 1983; Tenenbaum, 1982), but it is not the most desirable outcome. By contrast, findings of aptitude x treatment interactions are fairly common in the literature of cooperative learning (e.g., Hulten & DeVries, 1986; Webb & Kenderski, 1982; Edwards, DeVries & Snyder, 1972; Slavin & Oickle, 1981; Peterson, Janicki & Swing, 1981; Webb, 1977). It is likely that the AT1 results achieved here with Cooperative Group 2 were influenced solely, or at least primarily, by the presence of the cooperative learning strategy.

The obvious question to ask, of course, is why the results obtained for the two combined treatments are not consistent, especially since these experimental groups were to be treated in essentially the same way. The answer to this question lies in the formative evaluation data (these data are not presented here). One of the outcomes of this analysis was that the unit pacing was inappropriate (i.e., there was too much material to cover), and as a result, the instructional strategy all but broke down in Cooperative Group 1. Cooperative Group 2, on the other hand, was not as affected by problems of pacing. It is not surprising, then, that the instructional strategy produced a more positive effect in the condition that provided the best test of it.

Affective Outcomes

The affective measure included in this study appears to have detected differences that indicate a positive effect for the combined treatment conditions. From the results obtained from this measure, it is evident that the treatment attitudes of the two experimental groups combined were more positive than those of the unexposed (control) subjects. When examined individually, the post-treatment attitudes of Cooperative Group 2 exceeded those of the Control group, but those of Cooperative Group 1 did not. Here, as with the cognitive data, the differences between the two experimental treatments mirror the formative evaluation results.

Sociometric Outcomes

In both treatments, the students' sociometric status and emotional expansion scores were found to have improved as result of exposure to the instructional treatment. However, because this analysis was performed within treated groups only, it is impossible to determine if this occurred in the untreated control group as well. As well, it is likely that the primary influence in this result was the cooperative learning strategy. It is not the intention to diminish the importance of these findings, since interaction among classmates is clearly a desirable and somewhat unusual outcome in large undergraduate courses. But it is unlikely that the combining strategy substantially influenced these results (i.e., cooperative learning alone could have produced the same outcomes). Likewise, it is unlikely that such results would accrue from any combined treatment that did not involve enhanced student involvement, such as cooperative learning, as an element.

Issues in Designing Combined Instructional Treatments

While it is difficult to discern the exact reasons for the failure of the treatments to dramatically influence overall cognitive learning behavior, a number of problems, with the experimental conditions and with the theory itself, are candidates for consideration.

Combining of treatments. According to Bloom (1984), one of the major concerns of further research in combining instructional treatments is to uncover which two or three instructional variables can best be combined. He argues that to be successfully combined, variables must affect different objects of the instructional context, each contributed something unique to learning achievement. It is possible that some variables should not be combined because they compete with one another, they overlap one another or simply because one or more variables are not capable of producing the hypothesized effect on achievement.

Pacing of instruction. From the formative evaluation data, it is clear that the instructional potency of the design was severely minimized by the inappropriate pacing, especially in Cooperative Group 1. In almost every lesson, there was insufficient time provided to the student to allow them to integrate sufficiently the material they were learning. As a result, the grouped-based instructional activities became product-oriented rather than process-oriented. For example, in Cooperative Group 1 several instances were reported where students dictated answers to other students rather than teaching them. Consequently, one of the most important cognitive strengths of cooperative learning – namely, the clarification of concepts through oral review and explanation to others (Kohn, 1987) – was effectively nullified.

Matching objectives and the instructional strategy. Because of the introductory nature of the course in which this experiment was conducted, the objectives employed were relatively low-level (i.e., primarily knowledge and comprehension). While studies by Mevarech (1980, 1985), Tenenbaum (1986) and Slavin (1983) have shown that combining instructional treatments may influence both higher and lower mental processes, a greater benefit appears to accrue to higher forms of learning (Bloom, 1984). It is likely that skills such as problem solving are more amenable to combined treatments, especially when cooperative learning is among the variables being used.

Overlap of instructional variables. It is possible, even likely, that two of the three variables used in this experiment were too similar to have produced the combined effect proposed by Bloom. Cooperative learning is described by Bloom (1984) as affecting peer group relations, while enhanced student classroom participation is touted as an agent of influence affecting both the teacher and learner. In the present study, these designations are difficult to justify. The Jigsaw strategy not only alters the peer group structure of the classroom, it also changes the role of both student and teacher. Student becomes teacher, and teacher becomes facilitator and content expert. The same is true of student classroom participation. In fact, cooperative strategies represent on every structuredmeans ofensuringstudentparticipation. Hence, instead of these two strategies being complementary, they were in fact parallel, and highly similar in the influence they exerted on the learner, the teacher and the peer involvement. Since the rationale for choosing to combine specific strategies is guided by Bloom's classification system, the reliability of this system must surely be held in question.

Appropriateness of cooperative learning. Finally, it is conceivable that cooperative learning is an inappropriate strategy for combining. First, cooperative learning treatments have frequently been found to produce aptitude x treatment interactions, suggesting that it may not represent a reliable method of introducing general benefits across all kinds of students. Second, while the affective benefits of cooperative learninghave been well established, its effect on cognitive learning has been less reliable. A meta-analysis by Michaels (1977), one of three that have appeared in the literature, asserts that competition is better than cooperation in fostering cognitive learning.

Theoretical Uncertainties that Remain

In the introduction, several theoretical uncertainties were addressed: a) the appropriateness of combining variables in higher education; b) the question of whether variables other than mastery can be additive; the issue of whether variables with lower effect sizes may be combined; and d) Bloom's classification of the instructional variables in question. This final section addresses, in speculative fashion, these issues.

Combining variables in higher education. It is possible that combining instructional strategies is inappropriate for higher education. Cooperative learning, in particular, requires greater amounts of in-class time to achieve learning objectives than does conventional lecture and lecture/discussion methods, and as a result may not be amenable to the greater quantities of information that are generally associated with college and university courses. It is also possible that some subject matters lend themselves better to alternative methods than do others. There is little evidence from prior studies or from the current one to shed light on this issue.

Master learning as a necessary variable. Since the intention of the combining strategy is to emulate one-to-one tutoring, then mastery learning -the single strategy which most closely resembles it -may well be a necessary condition for successfully achieving the two sigma effect. The only experiment that has been performed to date which excludes mastery was one conducted by Nordin (1981) in Malaysia. This study was carefully designed so that it contained three essential factors: cues (stimulus); participation (response); and reward (reinforcement). It is unclear whether Nordin purposely aimed to approximate on-to-one tutoring, or if he was merely adhering to the instructional paradigm proposed by Dollard and Miller (1950) in which the three above features, plus motivation, are named as the essential features of human learning. What is clear is that all three factors used by Nordin are fundamental characteristics of one-to-one tutoring. It may be more important, then, to select variables that are components of tutoring, than to select variables that simply affect different objects in the instructional environment. The validity of this suggestion can only be determined in further research work.

Variables with lower effect sizes. Another uncertainty is the extent to which lower effect size variables, like advance organizers, contribute to the overall goal of substantially boosting cognitive achievement. Because of limitations beyond the control of the researchers, the variables in this study could not be effectively isolated to determine their relative affect on performance. Future research should include due consideration for these individual treatments in an attempt to determine the most parsimonious combination of alterable variables.

Bloom's categories. Finally, there is the issue of Bloom's so called "rule of thumb" for choosing variables to be combined. In the absence of mastery learning, a clear benefit to learning achievement, it is possible that Bloom's categories are far too general to perform effectively as prescriptions for success. It is not so much that the variables are mislabeled, but that depending on circumstances, different variables may perform similarly or may not exhibit the desired characteristics. For instance, the variable called feedback-corrective (mastery learning), may perform in essentially the same fashion as carefully graded homework assignments. Bloom describes the former as affecting the learner, and the latter as affecting the teacher. If the two overlap, the first nullifying the effects of the second, then surely the object being influenced is the same in both cases. In addition, if graded homework is not given sufficient in-class attention so that students become aware of their mistakes, it may have little more effect than ungraded homework. Similarly, cooperative learning (object = peer group relations) may have overlapped student classroom participation (object = learner/teacher), each effectively cancelling the additive benefits of the other.

CONCLUSION

Can instructional treatments be combined successfully in higher education courses to approximate the positive academic benefits of one-to-one tutoring? Clearly, this study has contributed little to answering this general question. It is only through studies like this one, however, that the limits and potentials of any instructional theory can be sorted out. Future research may well reveal that cooperative learning, in combination with the two other variables tested here, or some yet untested combination, may yield the desired effect. For now, however, we must suspendjudgment and await additional tests of Bloom's potentially important conception.

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