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A Meta-Analysis of the Relative Effectiveness of Two Cooperative Learning Models in Increasing Mathematics Achievement

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of Two Cooperative Learning Models in
Increasing Mathematics Achievement

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Abstract

The meta-analysis compares two popular cooperative learning models, Student-Teams-Achievement Divisions (STAD) and Teams-Games-Tournaments (TGT), for their relative effectiveness in increasing mathematics achievement of K-12 students. The findings of the available research were integrated to determine both the magnitude and the direction of the effects of the cooperative learning models and effect sizes were calculated. More studies comparing the TGT cooperative learning model with a traditional learning model (81% of the studies) resulted in statistically significant higher gains in mathematics achievement than studies comparing the STAD model with a traditional learning model (51% of the studies). Other measures of relative effectiveness did not clearly support the TGT cooperative learning model as the most effective method for increasing mathematics achievement. Mean effect sizes were compared by goal structure, grade level, length of study, and location.

Students who participated in studies comparing the STAD cooperative learning model with a competitive learning model achieved statistically significant higher gains in mathematics achievement than students

who participated in studies comparing the TGT cooperative learning model with a competitive learning model. In studies of 13 weeks or longer, students who were included in the TGT cooperative learning method as compared with a traditional learning method achieved higher gains in mathematics than students who were included in the STAD cooperative learning method. In studies of 13 weeks or less, students who were included in the STAD cooperative learning method as compared with a traditional learning method achieved higher gains in mathematics than students who were included in the TGT cooperative learning model.

When TGT and STAD studies were compared by grade level, the studies at the elementary level resulted in higher gains in mathematics achievement by students in TGT cooperative learning groups when compared with students in individualized learning models. Yet, when compared with students included in a competitive learning model at the elementary level, students involved in STAD cooperative learning groups garnered higher achievement gains in mathematics.

In studies conducted in urban settings, students participating in STAD cooperative learning groups achieved higher gains in mathematics than students

participating in TGT cooperative learning groups when compared with traditional learning models.

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Chapter 1

Introduction

Cooperation learning is an instructional strategy which involves a small group of students working together to reach a common goal. In cooperative learning, the group is heterogeneous, and activities are designed to make the group members interdependent in the most positive way. That is, students will attain the educational goals for which the group was created only if every group member achieves individual goals. So, in addition to the familiar social goals of group projects, cooperative learning allows students to actively help each other learn.

Cooperative learning has been proposed as a solution to an overwhelming number of school problems, particularly those problems found in urban settings, including the rapidly rising dropout rate, the increasing number of at-risk students, racial tension in the schools, and declining standardized test scores.

As an instructional strategy, cooperative learning has been suggested as an alternative to special programs for the gifted, remedial programs, ability grouping, Chapter I pull-out programs, and isolated

special education classes. Cooperative learning models have been reported to be successful as a means of (a) introducing higher level skills into the curriculum, (b) properly implemented, cooperative learning methods may make a positive contribution to social skills, self-esteem and academic achievement (Manning & Lucking, 1991).

Cooperative learning is a practical solution to today's competitive classroom environment; it is this competitive environment, researchers feel, that pushes low-achieving, unsuccessful students often found in urban classrooms to delinquency or withdrawal as a means of maintaining positive self-esteem in a hostile environment (Slavin, 1987). By providing opportunities for mutually supportive exchanges between individuals which may reduce the alienation some lower achieving students feel in competitive classrooms, cooperative learning experiences foster interdependence as a reality in our social existence and facilitate support for independence (Bronfenbrenner, 1980; Piaget, 1932; Rutter, Maugham, & Mortimer, 1979).

Purpose of Study

Although extensive research has been completed comparing one of the cooperative learning models with a traditional method of learning, this meta-analysis will compare two methods of cooperative learning and their relative effectiveness in significantly raising the achievement levels of K-12 students in the area of mathematics. The important difference in the two methods lies in their respective reward structures, and a comparison of the two widely-used methods will yield results that impact on educational decision-making. Both cooperative learning models are products of Johns Hopkins University and have been researched in numerous studies in comparison with a traditional learning model; this meta-analysis is aimed at refining the information about cooperative learning models.

Descriptions of the Cooperative Learning Models

The two cooperative learning models to be compared in this meta-analysis are Student-Teams-Achievement Divisions (STAD) and Teams-Games Tournaments (TGT). These popular cooperative learning techniques are similar in that they require teachers to assign students to four- or five-member teams composed of

high, average, and low-achieving students. Males and females and members of ethnic, racial, and ability groups are represented in roughly the same proportion as in the class. Both techniques have been used in a variety of subject areas and on elementary, middle school, secondary, and college levels. In STAD, students work in four- or five-member teams to master material presented by the teacher and then take individual quizzes. Teams are rewarded on the basis of each individual's improvement over his or her own past record. In TGT, students work in four or five-member teams to master material presented by the teacher; instead of quizzes, academic tournaments are held in which students compete to add points to their team scores. In both models, the three components of cooperative learning are clearly defined: (a) a cooperative activity structure--success in the task requires contributions from all group members; (b) a cooperative reward structure--group members are rewarded individually for group success; and, (c) individual accountability--the individual's contributions to the group's success is clear.

Reward Structure

Since the two cooperative learning models differ only in their reward structure, a brief description and review of reward structures follows. Classroom instructional technology can be described as a combination of three essential elements: a *task structure, a reward structure, and an authority structure*. The task structure is the mix of activities that make up the school day. Seatwork, lecture, and discussion are different task structures in use in most classrooms. Task structures may also vary as a result of the grouping system in use. Students may work individually, in homogeneous groups, or in heterogeneous groups. In groups, students may or may not be permitted to assist one another with their work.

The *authority structure* of the classroom refers to the control that students exercise over their own activities, as opposed to that exercised by teachers and other adults. In some classrooms, students have considerable choice about what they will study, how they will learn what they need to learn, and the sequence in which they will perform the prescribed set of tasks. In some classrooms, students can decide how

much they will do to earn a certain grade. The authority structure, relatively one-dimensional, varies from a high degree to student autonomy to a high degree of teacher-imposed or school-imposed structure.

The *reward structure* of the classroom may vary on several dimensions. Rewards for appropriate behavior may include grades, teacher approval, and tangible rewards. They may vary in frequency, magnitude, and sensitivity (the degree to which increases in performance are matched with increases in reward). The term *interpersonal reward structure* refers to the consequences for an individual of his classmates' performance. In a *competitive* reward structure, such as grading on the curve, one student's success necessitates another's relative failure. Michaels (1977) calls this *negative reward interdependence*, because students' rewards are linked to one another negatively. The opposite of competition is *cooperation*, such as is present in sports teams. In cooperation, or *positive reward independence*, one student's success helps another to be successful. The third interpersonal reward structure is *reward*

independence, or individualization, where students' goal achievements are unrelated to each other.

While cooperative learning may involve changes in all three of the major elements of classroom technology, it is primarily a change in the interpersonal reward structure of the classroom from a competitive reward structure to a cooperative one. Cooperative learning grew out of a laboratory tradition in social psychology that was clearly focused on the changes in reward structures, and the research on cooperative learning involves task and authority structure changes as secondary in interest to the changes in the interpersonal reward structure.

Two primary outcomes are important in research on reward structures: performance and cohesiveness. Performance refers to individual and group productivity on any variety of tasks; cohesiveness includes such variables as liking of others, feeling of being liked, group evaluation, and race relations. For the purpose of this study, only performance outcomes will be discussed.

Changes in reward structures often lead to mediating variables that have contradictory effects on

performance. The kind of performance and its measure, the task, the particular form of the reward structure and other factors make these mediating variables more or less important, and thus determine the net direction of the effect on performance.

Issues that need to be considered in predicting the effects of different reward structures on performance are (a) the contingency of an individual's rewards on performance--what are the chances that if an individual works hard, the work will be detected, recognized, and rewarded, and that if the individual does not work up to capacity that the rewards will be diminished; (b) the greatness of the potential rewards for performance--competitive success in a situation with a high probability of success is less satisfying than with a moderate or low probability of success; and (c) the likelihood that others will help or hinder task performance--a cooperative reward structure can create a general group norm favoring performance (Atkinson, 1958; Slavin, 1977; and Thomas, 1957).

Rationale for the Study

While the body of research involving comparisons of the two cooperative learning models with traditional

instructional strategies is extensive and has produced positive effects, negative effects, and no effects, a meta-analysis of the effects could add to the body of knowledge about cooperative learning. Researchers advocate investigating cooperative learning models to test their effects and to broaden our understanding of how and why cooperative learning produces its various effects. This meta-analysis will provide teachers with information about two cooperative learning models suitable for use in their classrooms, since the models are similar in design and implementation differing only in their reward structure.

In STAD, group study is followed by individual quizzes; in TGT, group study is followed by intergroup competition, or tournaments, which involves a group winner and its individual group members winning a tangible reward. The TGT cooperative learning model will produce the greater achievement effect due to increased motivation on the part of the students to master the material in order to win the tournament and the prize. The existence of intergroup competition has raised the questions among cooperative learning researchers regarding the relationship between

intergroup competition and increases in academic achievement. The Johnsons (Johnson, D. & Johnson, R., 1974, 1975, 1983) support the belief that cooperative learning without competition (pure cooperation) provides the greatest achievement gains, while Slavin (1978, 1980, 1983, 1984) postulates that cooperative learning with competition provides the greatest achievement gains. Still others (Michaels, 1977; Moskowitz, Malvin, Schaeffer & Schnaps, 1984; and Sharan, 1980) believe that the reward structure of the cooperative learning models motivates the students to greater academic gains.

Fewer and fewer students are entering the fields of mathematics, science, and engineering. Researchers propose that poor attitudes toward mathematics (generally as a result of poor achievement) and subsequently poor achievement in mathematics may be the causes (Slavin, 1990). The effects of a specific cooperative learning experience may tend to improve the attitudes toward school and academic subjects held by students (Hulten & DeVries, 1976).

Effective schools research revealed that high-achieving schools are most likely to be characterized

by students who feel that they have control or mastery of their academic work, by the students receiving numerous opportunities to participate, and by positive school climates (Rutter et al., 1979). An abundance of anecdotal evidence suggests that, for individuals, the decision to drop out of school results from an accumulated sense of failure, loss of control, and alienation (Doyle, 1988; Flint, 1988; Kolstad & Owings, 1986; Lake, 1988; McDill, 1986; Natriello, 1987; Orr, 1987; and Wehlage, 1986). In cooperative learning experiences, students may feel more successful in their academic work, and may receive numerous opportunities to participate.

Learning mathematics in cooperative learning groups can give students the incentive to continue studying mathematics as long as they are in school because learning cooperatively is a more enjoyable way to learn. Students must recognize the varied roles played by mathematics in society, from accounting and finance to scientific research, from public policy debates to market research and political polls. Students' school experiences must bring them to believe that mathematics has value for them.

Specific learning models can help students to learn and to reason mathematically. In their groups, students learn to gather evidence, make conjectures, formulate models, invent examples, and build sound arguments. In so doing, they develop the informed skepticism and sharp insight for which the mathematical perspective is valued by society.

In an era marked by high unemployment, students must make their skills as marketable as possible. Employers repeatedly stress the importance of being able to work with a team on common objectives. Most complex problems demand the talents of many different people. Students of mathematics must learn how to work with others to achieve a common goal; they must learn to plan, to discuss, to compromise, to question, and to organize. Teamwork in the classroom not only teaches these skills, it is an effective way to learn mathematics--by communication with peers (Steen, 1989).

Meta-analysis

The extensive body of research involving comparisons of the two cooperative learning models with traditional instructional strategies can be clarified

by a meta-analysis, or a study of studies, comparing the STAD studies with the TGT studies.

A meta-analysis is a statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings. A meta-analysis is appropriate for this study since both TGT and STAD have been extensively researched in comparison with traditional models of instruction. A logical way to organize and extract information from the large masses of data surrounding these cooperative learning models in search of a general conclusion regarding their relative effectiveness is through meta-analytic techniques.

The basic concepts underlying meta-analysis were employed decades ago by Thorndike (1922) and Ghiselli (1949) and more recently by Fleishman and Levine and their associates (Levine, Kramer, & Levine, 1975; Levine, Romashko, & Fleishman, 1973). Thorndike and Ghiselli cumulated results across studies based on the use of average correlations. Thorndike (1933) went further and corrected the observed variance of findings across studies for the effects of sampling error. Fleishman and Levine and their associates cumulated

effect sizes across experimental studies (1973). None of these authors advanced a systematic body of meta-analysis methodology for use in solving the general problem of integrating findings across studies to produce cumulative knowledge. Glass (1976) advanced the first such set of procedures and coined the term "meta-analysis" to refer to the analysis of analyses (studies). One reason he introduced this term was to distinguish such analyses from secondary analysis in which the researcher obtains and reanalyzes the original data on which an earlier study was based. Meta-analysis is the quantitative cumulation and analysis of descriptive statistics across studies. A meta-analysis does not require access to original study data.

Glassian meta-analysis has been applied to research studies on the effects of psychotherapy (Miller, 1977), the treatment of stuttering (Andrews, 1979), modern versus traditional math instruction (Anthappilly, 1980), student ratings of instruction and student achievement (Cohen, 1980), effects of personalized instruction systems (Hartley, 1977), and to other sets of research studies. In each case, the

results clarify the previously mixed set of results and allow fairly specific conclusions.

The controversy regarding reward structure, the failure to derive a consistent conclusion from the research concerning cooperative learning, and the increasing emphasis on student achievement provide the impetus for examining the research which has been conducted on the two cooperative learning models. Mathematics was chosen as the subject for this cooperative learning meta-analysis since (a) mathematics is taught in public schools from grades K-12, (b) mastery of mathematical concepts and computational procedures is relatively easy to test, (c) the number of students seeking careers in mathematics is rapidly declining due in part to a disliking for the subject, and (d) information from the meta-analysis could guide mathematics teachers to select a cooperative learning model for their classrooms. The results of the meta-analysis should be generalizable to urban, suburban, and rural public school populations in grades K-12 throughout the United States. As a meta-analysis provides a characterization of the trends of research and also yields information

about the magnitude of any difference between the conditions, it should provide the basis for more precise and confident statements concerning the relative effects of TGT and STAD.

Statement of the Problem

Which cooperative learning model, Student-Teams-Achievement Divisions (STAD) or Teams-Games-Tournaments (TGT), produces greater achievement gains in mathematics? This study will identify the research that has been indexed in either ERIC (Education Resources Information Center), PSYCHLIT (Psychological Literature), or Dissertation Abstracts International prior to June, 1991, concerning the effects of using either cooperative learning technique in the mathematics instruction. The findings of the available research will be integrated to determine both the magnitude and the direction of the effects of two specific learning models on the mathematics achievement of students.

Chapter 2

Review of the Literature

Research on cooperative learning methods has taken place in grades two through twelve; in urban, suburban, and rural schools; and in mathematics, language arts, social studies, and science. The findings are that certain forms of cooperative learning, when compared with traditional learning, are consistently effective in increasing students' achievement usually measured by standardized tests (Allen and Van Sickle, 1984; DeVries and Slavin, 1978; Okebukola, 1985; Sharan et al., 1984; Sherman & Thomas, 1986; Slavin & Karweit, 1984).

Johnson and Johnson (1981) indicate a number of benefits for students who learn mathematics in cooperative groups: higher achievement; better attitudes toward mathematics, self, and teachers; and better acceptance of each other. Although cooperative learning techniques have been explored in laboratory settings since the 1920s (Maller, 1929), practical classroom applications have been available only since the 1970s (Slavin, 1980).

This chapter provides a comprehensive review of cooperative learning and the controversies which

surround the subject. The review is organized in the following manner: first, a brief discussion of reward structures is presented followed by a summary of the major reviews of the literature responsible for the controversies. A description of the two cooperative learning models in question follows. A discussion concerning the part that the motivation to win a tournament and the reward of a positive tangible prize might have on the TGT cooperative learning model showing greater achievement gains in mathematics is last.

Reward Structures

Slavin (1980) stated that the structure of the classroom is composed of three elements: a task structure, a reward or goal structure, and an authority structure. Slavin defined task structure as "...the mix of activities that make up the school day" (p. 315) and authority structure as "...the control that students exercise over their own activities, as opposed so that exercised by teachers and other adults" (p. 31). Reward or goal structures commonly refer to the conditions described by Deutsch (1949). These goal structures are: (a) cooperation, (b) interpersonal

competition, and (c) individualistic efforts. Michaels (1977) provided a definition of cooperation with intergroup competition.

<u>Cooperation</u>. Cooperation, which is also called *pure cooperation*, exists with no competition with the group or between groups. Rewards and goal attainments are unrelated among groups but positively related among individuals within the group. Students are grouped and work to help each other learn a specific concept; individual tests for mastery of the concept are given and individual scores are recorded.

<u>Interpersonal competition</u>. This reward structure refers to competition among peers with no group involvement. Rewards and goal attainments are differentially allocate among the individuals relative to their individual performance. This method has been the preferred model in most schools and is often referred to as *traditional learning*. Students may be taught by lecture, perhaps followed by discussion, an worksheet for guided practice, and a homework assignment for reinforcement. Mastery of the concept is tested individually, and students compete with one another.

Individualistic efforts. In this model, the allocation of rewards or goal attainments are unrelated among individuals and are based on a comparison of the individual's present performance as compared to his or her past performance. Students are taught by lecture and, after practice, are tested for mastery. Their scores are improvement scores over previous scores.

Cooperation with intergroup competition. In this cooperative learning model, rewards or goal attainments are differentially allocated among groups according to their relative performances, and the group rewards are equally distributed within each group. Individuals work in groups to master material presented by the teacher, they compete with each other in groups for prizes or rewards, they are tested individually on the material, and their individual grades are improvement scores. Groups compete by adding their improvement scores with the winning group amassing the greatest improvement score.

The two models considered in this meta-analysis, TGT and STAD, are models of cooperation with intergroup competition. In addition, TGT involves the

participation of students in tournaments in which the winner receives a tangible prize.

Slavin (1980, 1983) stated that while cooperative learning may involve changes in all three elements of the structure of a classroom, the goal structure is the primary element changed and is the basis of the research on cooperative learning. Cooperative learning involves two goal structures, cooperation without intergroup competition and cooperation with intergroup competition.

Controversial Issues

TGT and STAD are models of cooperation with intergroup competition. No studies exist which compare TGT and STAD for their relative effects on mathematics achievement, but there is an abundance of research information involving cooperative learning methods as compared with interpersonal competition and with individualistic efforts and their relative effects on achievement. Controversies are described below.

Favoring pure cooperation. The major controversy surrounding the topic of cooperative learning focuses on pure cooperation versus cooperation with intergroup competition. Johnson, et al., (1981) conducted a meta-

analysis of 122 studies which examined the effects of cooperation, cooperation with intergroup competition, interpersonal competition, and individualistic efforts on achievement and productivity. The studies reviewed consisted of research which compared the effects of goal structures on preschool students, school-age children, post secondary students, and adults on achievement and productivity in nap behavior, puzzle solution, maze learning, industrial arts, acting, committee productivity, and sports performance in addition to academic tasks. Johnson, et al., (1981) stated that both cooperation and cooperation with intergroup competition are more effective in promoting achievement and productivity than interpersonal competition and individualistic efforts. It was also reported that the cooperation groups were superior in promoting achievement and productivity than were the groups which involved intergroup competition.

In an investigation of eight studies which compared cooperation without intergroup competition with interpersonal competition and individualistic efforts, Sharan (1980) stated that the research indicated that cooperation resulted in higher academic

gains that either interpersonal competition or individualistic efforts. The research reviewed also compared cooperation with and without intergroup competition and found that, overall, cooperation without competition produced higher academic gains than cooperation with competition.

In Slavin's (1980) examination of 25 studies comparing the effects of cooperation with intergroup competition or cooperation without intergroup competition with individual goal structures, six studies which compared the effect of cooperation without intergroup competition with one of the individual goal structures produced ten measures of academic achievement with five statistically significant effects favoring the cooperative goal structure.

Favoring cooperation with intergroup competition.

The Johnson meta-analysis favoring pure cooperation over cooperation with intergroup competition was quickly and harshly criticized by other researchers (Cotton & Cook, 1982; McGlynn, 1982; Slavin, 1983) since their research indicated that

cooperative learning with intergroup competition was more effective.

While Michaels' (1977) review of ten studies comparing four reward structures found that interpersonal competition is the most effective goal structure for increasing academic performance, the research also postulated that both cooperation with intergroup competition and individualistic efforts appear to be more effective in increasing academic performance than cooperation without intergroup competition.

Sharan (1980) reviewed ten studies which provided for comparison of three alternative goal structures. While two studies reported no significant differences in academic achievement between interpersonal competition and cooperation with intergroup competition, in eight other studies, cooperation with intergroup competition was reported to provide for higher academic gains when compared with either individualistic efforts or cooperation without intergroup competition.

Slavin (1980) examined 25 studies which compared the effects of cooperation with intergroup competition

or cooperation without intergroup competition with one of the individual goal structures on academic achievement. Slavin compared these studies using a vote table (a chart of the direction and results of comparisons) which indicated that 19 studies compared cooperation with intergroup competition with one of the individual goal structures and produced 35 measures of achievement which showed a significant difference favoring cooperation with intergroup competition.

In his review of 46 studies which compared the academic achievement of classes using one of the cooperative goal structures with the academic achievement of a class which used one of the individual goal structures, Slavin (1983) reported that cooperation with intergroup competition consistently increased student achievement in elementary and secondary schools (89% found a positive effect, 11% found no difference). It was also reported that cooperation without intergroup competition appears to be no more effective than traditional methods as a means of increasing academic achievement; eight of nine studies showed no significant differences between the

goal structures and one study indicated that individualistic efforts were more effective than pure cooperation.

Favoring interpersonal competition. Michaels (1977) conducted a review of ten studies which used students as subjects, compared at least two reward structures, and administered rewards. He concluded that interpersonal competition is the most effective goal structure for increasing academic performance.

Contradictory results. Saran (1980) conducted an analysis of 24 studies which compared the effects of different goal structures on academic achievement, attitudes, and race relations. This analysis provides contradictory conclusions regarding the efficacy of the different goal structures. Sharan examined four studies which compared cooperation without intergroup competition with individualistic efforts and found no significant difference in the achievement of white students; however, there was a significant increase in the academic achievement of Mexican-American and African-American children when compared to the achievement of their ethnic peers in the classes which employed individualistic effort goal structures.

Descriptions of the TGT and STAD Models

Of eight methods of cooperative learning which account for the majority of research in this area, the two methods under question in this study are both methods which utilize cooperation with intergroup competition. Student Teams-Achievement Divisions (STAD) was developed by Slavin in 1978 and Teams-Games-Tournaments was developed by Edwards and DeVries in 1972.

In STAD, students are divided into four-or-five-member heterogenous teams. The composition of the teams matches the composition of the class in terms of ethnicity, gender, and student ability. Following the teacher's presentation of a lesson to the entire class, the teams participate in group activities (study spelling words or prepare charts, for instance) designed to prepare the individual team members for a fifteen-minute quiz. The quiz scores are translated into team scores using a system called *achievement divisions*. The quiz scores of the highest six students in past performance are compared, and the top scorer in this group (the achievement division) earns eight points for his or her team, the second scorer earns six

points, and so forth. Then the quiz scores of the next highest six students in past performance are compared and so on. In this way, student scores are compared only with those of an ability-homogeneous reference group instead of with the entire class. The achievement division feature maintains the equality of opportunity for contributions to the team score as in TGT.

TGT is essentially the same as STAD in regard to team formation, rationale, and method. The primary differences between TGT and STAD are in the ways in which individuals are evaluated, in the ways in which teams compete, and in the existence of a tangible reward. The quizzes and improvement scores found in STAD are replaced with a system of academic game tournaments in which each student competes with other students from the other groups with the same level of past performance.

Because students are assigned to ability-homogeneous tournament tables, each student has an equal chance of contributing a maximum score to his or her team, as the first place scorer at every table brings the same number of points to his or her team.

Following the tournament, the teacher recognizes successful teams as first place scorers with prizes and recognition in a weekly newsletter.

Learning Theory. The term *learning theory* is misleading since it implies that only one theory of learning exists. In fact, there have been and continue to be opposing views. Debate abounds about the way the principles of learning theory operate and about the importance of the role they plan in promoting changes in a child (Gagne, 1965).

The basic principles of learning theory are as follows: (a) an organism acts in a certain way in a specific context or situation; (b) that act is followed quickly by some change in the environment--the reinforcement--that the organism notices; and (c) the reinforcement leads to an increased likelihood that the organism will repeat the act again in the same or a similar situation (Gage & Berliner, 1984).

Psychologists who want to account for the increased likelihood of a reinforced behavior suggest that the reinforcement produces a change in the strength of the bond means that the next time the organism is in that situation and desires that

reinforcement, he is likely to repeat the act that originally led to the reinforcement. The objects or events that have the power to elicit the response are called the *conditioned stimuli*. The act that is repeatedly elicited is called the *conditioned response*. (Kagan, 1989; Knoff, 1986; Miller, 1951; Skinner, 1960)

Many psychologists refer to learning as a change in an organism that lasts longer than a few moments. Three different kinds of change occur as a result of a child's experience in the world: (a) changes in behavior, (b) changes in knowledge and cognitive skills, and (c) changes in emotional feelings (Kagan, 1989; Knoff, 1986; Miller, 1951; Skinner, 1960). It is important to recognize that behavior, cognition, and feelings are not isolated processes in the child, and often a change in one is accompanied by a change in another. Changes in action, cognition, and emotion that develop as a matter of course among most children differ from those that develop only as a result of specific teaching or observation.

Although many complex and interrelated acts are involved in learning a new competence or acquiring new knowledge, they can be clustered around two fundamental

actions of learners that lead to change: the learner is observing and the learner is engaged in reflective thought. Observation of events may produce a change in action through (a) imitation or the behavioral expression of an observed act, (b) accomodation to new events, and (c) reinforcement for successful actions, thoughts or feelings.

The principles of learning theory are used to modify behavior and are of particular importance with regard to cooperative learning techniques. Students gain knowledge through observation; that is, through listening to and watching others, looking at objects, noticing the resultls of his own actions, and reading. Students participating in cooperative learning activities gain knowledge through imitation in order to increase their similarity to a model or to produce excitement. Students participating in cooperative learning activities expand their understanding of the world by relating new experiences to old ones and changing their concepts accordingly through the process of accommodation. To accommodate, students must focus their attention on the unfamiliar occurrence of group learning, make a mental adjustment to learning a new

way, relate the event to their previous knowledge, and generate a new mental representation that takes into account both the old and the new information. Students who participate in cooperative learning activities reinforce the learning of concepts by teaching them to their teammates. The possibility of winning a tournament such as those found in the TGT cooperative learning model is also a positive reinforcer. (Slavin, 1983)

Motivation. Motivation is the term used to describe what energizes a person and what directs his or her activity. Energy and direction are at the center of motivation (Gage & Berliner, 1984). Motivation is a diffuse concept and is often tied to other factors that influence the energy and direction of behavior--factors such as interest, need, value, attitude, aspiration, and incentive. An incentive is something the student perceives as having the capability of satisfying an aroused motive. It draws him or her to action aimed at acquiring the incentive. The student motivated by curiosity has understanding or knowledge as an incentive. If achievement is the motive, then success, honor, or good grades will serve

as incentives. Money, valued prizes, love and freedom are other powerful incentives. The fact that incentives arouse activity is the clue that behavior modification techniques use this aspect of motivation to the fullest. A person under the stimulus control of a powerful incentive will show increases in energy expended and changes in the direction of his or her behavior (Gage & Berliner, 1984; Gagne, 1965; Gagne & Merrill, 1990).

Gagne (1965) contends that *acquisition* is a need which affects a student's work habits. This need includes obtaining possessions and property and working for money and goods. The theories focusing on intrinsic and extrinsic rewards and based on the theory of needs (Thorndike, 1938; Gagner, 1965; and Gage and Berliner, 1984). Motivation without apparent reward is referred to as *intrinsic*; motivation with an observable reward is referred to as *extrinsic*. Gage and Berliner (1984) support the position that all people are motivated by the reinforcing consequences of their past behavior; therefore, behaviors that appear to be intrinsically motivated are really motivated by the person's past experiences. One who derives pleasure

from playing the piano at a party (seemingly intrinsically motivated behavior) has simply developed self-reinforcement processes fostered by earlier social approval of parents or teachers.

In one series of studies (Gagne & Merrill, 1990) students' initial interest in an activity was measured. They were then allowed to continue that activity knowing they were to be rewarded for their efforts. Other groups of students either received no reward or were rewarded unexpectedly. The groups that engaged in activities for an expected reward showed a relative decrement in performance. The effect of presenting activities in the context of a system of extrinsic incentives may be to undermine that intrinsic interest in those activities. Activities of initial interest may be come drudgery which children engage in only when external pressures are present to force or lure them to do so.

Linked to the theory of needs are the theories supporting instructional strategies such as *token economies and contracts* that are so popular in classrooms today (Cohen, 1973). Also, instructional games and simulations motivate students, promote

interaction, present clear pictures of real-life situations, and make possible direct involvement in the learning process.

The existence of a game-like tournament and of a tangible prize for winning in studies using the TGT cooperative learning model is likely to produce a greater mathematics achievement effect when compared with studies using the STAD cooperative learning model.

Summary

This chapter has provided a review of the literature with a brief discussion of goal structures and a review of the major reviews which have been largely responsible for creating the contradictions concerning cooperative learning methods and academic achievement. A description of the two cooperative learning models in question was included to provide for clarification. Last, a brief review of the research on motivation and achievement was included.

The available data have provided contradictory conclusions and have been used to support or refute claims by researchers. Research has shown that there are no differences in achievement between students using cooperative or individualistic methods (Hayes,

1976) and that cooperation provides for higher academic gains that do individualistic efforts (Sharan, 1980). Research has also shown that interpersonal competition is the most effective goal structure (Michaels, 1977); research has shown that interpersonal competition is no more effective than cooperation without competition (Slavin, 1984); and research has shown that interpersonal competition is less effective than cooperative methods (Sharan, 1980).

Johnson, Maruyama, Johnson, Nelson, and Skon (1981) stated that cooperation without intergroup competition is the most effective method for increasing achievement while Slavin (1984) stated that intergroup competition is the factor responsible for increased achievement.

Evidence can be found in the literature which supports all positions regarding the effectiveness of using cooperative learning methods to provide for increased academic achievement. However, since there exists no comparison of TGT and STAD and their relative effects on mathematics achievement, this meta-analysis aims at providing a necessary addition to the existing body of research by evaluating measurable objective

data from a broad generalizable base of data from different populations.

CHAPTER 3

Meta-analysis

This chapter provides a description of the studies included in the vote table and in the meta-analysis and will also include the vote table and in the meta-analysis and will also include the calculation of effect sizes. A computer search of the ERIC database, PSYCHLIT database and Dissertation Abstracts International prior to June, 1991 was conducted. In addition, references cited in the articles identified through the computer search were examined to identify any possible research not included in the computer search.

Effect sizes were calculated using the following formula:

$$ES = \frac{x_c - x_t}{s_t}$$

An effect size (ES) for the purpose of this study is the mean difference of academic achievement in math between the students taught under a cooperative learning condition (x_c) and students taught under traditional competitive or individualistic conditions

(x_t) divided by the standard deviation of the traditional group (s_t).

Holmes (1984) has devised a formula to be used when x_c and, x_t the size of each group *N*, and the value of Fisher's *F* are reported. As *F* is equal to t^2 when testing the null hypothesis $H_0 : u_1 - u_2$. The following formula can be used to calculate the effect size.

$$ES = \sqrt{F\,(\frac{1}{n_c} + \frac{1}{n_t})}$$

Criteria for Selection of Studies

Studies were included in the meta-analysis if (a) the cooperation learning method used was STAD or TGT; (b) the study was conducted in a public school; (c) students in grades K-12 participated; (d) students were tested for achievement in mathematics; and (e) the study compared the cooperative learning model to a pure cooperative model, to an interpersonal competition model or to an individualistic model.

The studies selected for meta-analysis and summarized below are not equally strong. Published research is biased in favor of significant results because nonsignificant results are rarely published.

Also, since students typically remain in intact groups for instruction, most educational studies are quasi-experimental. However, Glass (1976) believes the difference in well-designed and poorly-designed studies to be so small that to integrate research results by eliminating the poorly-done studies is to discard a vast amount of important research. Huge numbers of studies may be excluded on methodological grounds: poor design, inaccurate measurement, or badly implemented treatment.

Yet evidence is never given to support the assumption that the deficiencies of these studies influenced their findings (Glass, 1980). Meta-analytic procedures integrate results from existing studies to reveal patterns of relatively invariant underlying relations and casualties to constitute general principles and cumulative knowledge (Hunter et al., 1982). In studies comprised of several comparisons, each comparison is referred to as a *conclusion*. Effect sizes from individual conclusions are averaged to determine a mean effect size. In studies involving a single comparison, one effect size is reported.

Table 1 lists the researchers, publication dates, and locations of the studies included in the meta-analysis. Descriptions of the individual studies follow Table 1 and information is presented in the order of sample, location and setting, methods, variable, findings, and effect sizes.

Table 1.

Studies Included in the Meta-analysis

Author(s)	Date	Location
Edwards, DeVries, & Snyder	1972	Urban US
Gabbert, Johnson, & Johnson	1986	Suburban Midwest
Glassman, P.	1988	Suburban NY
Gordon, A.B.	1985	Urban Northeast
Johnson, Johnson & Scott	1978	Suburban US
Johnson, L.C.	1985	Suburban TX
Martin, J.M.	1986	Urban MD
Mesch, Lew, Johnson, Johnson	1986	Suburban Northwest
Mevarech, Z.R.	1985	Israel
Moskowitz, Malvin, Schaeffer	1983	Suburban CA
Peterson, Janicki & Swing	1981	Rural WI
Ross, J.A.	1988	Urban Ontario
Sherman & Thomas	1986	Rural Midwest
Slavin, R.E. (Study 1 and 2)	1984	Suburban MD
Slavin & Karweit	1984	Rural MD
Talmage, Pascarella & Ford	1984	Suburban Chicago
Yager, Johnson, & Snider	1986	Urban Midwest

Review of Studies and Calculation of Effect Sizes

Edwards, K.J., DeVries, D.L., & Snyder, J.P. (1972). Games and Teams: A winning combination. Simulation and Games, 3, 247-269.

Sample

The sample consisted of 96 seventh grade students. Approximately one-half of the students were low-ability students.

Location and Setting

The study was conducted in four seventh-grade general mathematics classes in a large urban junior high school. All four classes were taught by the same teacher who was in her first year teaching.

Method

Two math classes were assigned to the TGT condition and two to the individualistic condition. Each condition had an average and a low ability class; the individualistic condition classes met during the fourth and sixth periods of the school day while the TGT condition classes met during the first two periods.

Both conditions studied operations on fractions, decimals, and percents. Both conditions listened to lectures, did math problem drills in class, took three

quizzes and received individual feedback on drills and quizzes. The TGT group participated in games and tournaments twice a week and received feedback based on group contingencies.

A nonequivalent control group quasi-experimental design was used and the data were analyzed through analysis of variance and regression analysis.

Variable

The dependent variable in this study was mathematics achievement as measured by scores on the Computations Subtest of the Stanford Achievement Test in Mathematics, by 25 topic specific questions from the Stanford Achievement Test, and by a divergent solutions test designed by the experimenters to measure achievement.

Findings

The data indicate that the TGT group performed significantly better on all three measures than did the individualistic group. Low ability students appeared to make the higher gains on the computation tests while the average to high ability students appeared to make the higher gains on the divergent solutions test.

Effect Sizes

Three effect sizes will be calculated from the data available in this study using the Holmes method: effect size for the computation subtest, effect size for the content relevant items, and effect size for the divergent solutions test.

Computations Subtest. Each group had an N of 48 with an F value calculated to be 4.658.

$$ES = \sqrt{4.658\left(\frac{1}{48} + \frac{1}{48}\right)} = 0.441$$

The effect size is positive because the TGT group achieved the higher gains.

Content Relevant from Computations Subtest. Each group had an N of 48 with a calculated F value of 5.27.

$$ES = \sqrt{5.27\left(\frac{1}{48} + \frac{1}{48}\right)} = 0.469$$

The effect size is positive because the TGT group achieved the higher gains.

Divergent solutions test. With each group having an N of 48 and a reported F value of 5.78, the effect size is calculated to be:

$$ES = \sqrt{5.78\left(\frac{1}{48} + \frac{1}{48}\right)} = 0.491$$

The effect size is positive because the TGT group achieved the higher gains.

Mean Effect Size = 0.467

Gabbert, B., Johnson, D.W., & Johnson, R.T. (1986). Cooperative learning, group-to-individual transfer, process gain, and the acquisition of cognitive reasoning strategies. Journal of Psychology, 120(3), 265-278.

Sample

The sample for this study consisted of two first-grade classes. The 52 subjects, 28 girls and 24 boys, were from middle-class backgrounds.

Location and Setting

The study took place in two first-grade classes from a large, suburban elementary school in a large midwestern city.

Method

A stratified random sampling procedure was used to assign students to conditions so that equal percentages of high-, medium-, and low-ability students and equal

percentages of boys and girls were included in both conditions. Twenty-six students were assigned to each condition. Two first-grade teachers taught the instructional sessions. Each had received 90 hours of training in the use of cooperative learning (TGT) and individualistic learning and were experienced in their use. They were randomly assigned to and rotated across conditions. In addition, they followed written scripts daily so that the instructions for each condition were consistent for each teacher.

A 1 x 2 or a 2 x 3 analysis of variance was used to analyze the differences among conditions.

<u>Variable</u>

The dependent variable in this study is mathematics achievement as measured by tests created by the researchers to represent different levels on Bloom's (1956) taxonomy of educational objectives.

<u>Findings</u>

The data indicate that the cooperative learning groups performed significantly better in all four measures of mathematics achievement than did the students in the individualistic condition. On all four tests, high-ability students achieved the highest;

medium-ability students, the next highest; and low-ability students, the lowest.

Effect Sizes

Three effect sizes will be calculated from the data available in the study: effect size for missing addends, effect size for story problems, effect size for triangles, and effect size for circles. All effect sizes will be calculated using the Holmes method.

Missing Addends. Each group had an N of 26 with an F value calculated to be 8.84.

$$ES = \sqrt{8.84\left(\frac{1}{26} + \frac{1}{26}\right)} = 0.819$$

The effect size is positive because the TGT group achieved the higher gains.

Story Problems. Each group had an N of 26 with an F value calculated to be 28.30.

$$ES = \sqrt{28.30\left(\frac{1}{26} + \frac{1}{26}\right)} = 1.46$$

The effect size is positive because the TGT group achieved the higher gains.

Triangles. Each group had an N of 26 with an F value calculated to be 20.41.

$$ES = \sqrt{20.41\ (\frac{1}{26} + \frac{1}{26})} = 1.24$$

The effect size is positive because the TGT group achieved the higher gains.

<u>Circles</u>. Each group had an N of 26 with a calculated F value of 18.13.

$$ES = \sqrt{18.13\ (\frac{1}{26} + \frac{1}{26})} = 1.17$$

The effect size is positive because the TGT group achieved the higher gains.

Mean Effect Size: 1.340

Glassman, P. (1988).

A study of cooperative learning in mathematics, writing and reading as implemented in third, fourth, and fifth grade classes: a focus upon achievement, attitudes and self-esteem for males, females, blacks, Hispanics, and Anglos. Paper presented at the American Educational Research Association, New Orleans, LA, April 5-9, 1988.

Sample

The subjects for this study were 959 third-, fourth-, and fifth-graders from 24 classrooms.

Location and Setting

The study was conducted in two large intermediate schools in a large, middle-class, suburban district in New York.

Method

Twenty-four third-, fourth-, and fifth-grade teachers from two schools were included in the study. Twelve were instructed in the use of the Student-Teams-Achievement Divisions model of cooperative learning. STAD teachers used the cooperative learning model for scripted lessons and traditional learning teachers were instructed to teach their classes in their normal manner.

The students participated in the study for one academic year. All students were taught using the same material and the time spent on the subject areas was approximately the same.

A pretest, posttest quasi-experimental design was used. Analysis of variance was used to analyze the data.

Variable

The dependent variable of interest in this study was academic achievement in mathematics as measured by the Iowa Tests of Basic Skills (ITBS). The ITBS was used as the pretest and as the posttest.

Findings

This study found no statistically significant differences for academic achievement in mathematics between the experimental and control groups.

Effect Size

One effect size will be calculated from this study: mathematics. The effect size will be calculated using the definitional formula. The cooperative group had an adjusted mean score of 41.20 while the individualistic group had an adjusted mean score of 41.40 with a standard deviation of 9.35.

$$ES = \frac{41.20 - 41.40}{9.35} = -0.021$$

The effect size is negative because the individualistic group achieved higher gains.

Goldberg, L.F. (1989)

Implementing cooperative learning within six elementary school learning disability classrooms to improve math achievement and social skills. Ed.D, Practicum, Nova University.

Sample

The sample consisted of 47 students enrolled in 6 learning disability classrooms.

Location and Setting

The study was conducted in 6 learning disability classrooms in three elementary schools. All schools were located in a large urban school district in a city in the northeast.

Method

Three schools were selected on the basis of willingness to participate in the study. Teachers were assigned to either a control group (Individualistic) or treatment group (cooperative learning with intergroup competition: TGT).

The three teachers in the treatment group were given instruction in the use of TGT and instructed their mathematics classes using this method. The three teachers in the control group instructed their

mathematics classes using the same materials as the experimental group but used traditional individualistic methods normally used with learning disabled students. The study was conducted over a ten-week period.

A non-randomized control group pretest-posttest quasi-experimental design was used. Chi-square and two way analyses of variance were used to analyze the data.

Variable

The dependent variable of interest in this study consisted of mathematics achievement measured as gains on the mathematics curriculum unit tests developed by the school system. The tests were used as both a pretest and as a posttest.

Findings

The cooperative group significantly exceeded the individualistic group in mathematics achievement.

Effect Size

The effect size will be calculated from this study using the definitional formula. The cooperative group had an adjusted mean of 7.08 while the individualistic group had an adjusted mean of 5.48 with a standard deviation of 1.74.

$$ES = \frac{7.08 - 5.48}{1.74} = 0.919$$

The effect size is positive because the higher scores were attained by the cooperative group.

Gordon, A.B. (1985).

Cooperative learning: A comparative study of attitude and achievement of two groups of grade seven mathematics classes. (Doctoral dissertation, Brigham Young University), Dissertation Abstracts International, 47, 772A

Sample

The sample consisted of 55 seventh grade students (29 boys and 26 girls) enrolled in two mathematics classes. The students' ages ranged from 11 to 13 years.

Location and Setting

The study was conducted in two classes taught be the same teacher in a British Columbia, Canada middle school.

Method

All seventh grade mathematics students were randomly assigned to one of three classes, stratified

on the basis of achievement. One of three teachers was randomly chosen to participate in the study.

The participating teacher was trained in the use of cooperative learning methods with intergroup competition (TGT) and was instructed to teach one class using the cooperative method and to teach the other class using individualistic (traditional) methods. The study was conducted over eight weeks with both conditions using the same materials.

A pretest-posttest control group design was used in conducting the study. Data were analyzed using an analysis of variance.

Variable

The dependent variable of interest in this study was mathematics achievement as measured by the British Columbia Mathematics Assessment. Form A was used as a pretest and Form B was used as the posttest.

Findings

There were no statistically significant differences in mathematics achievement between the two conditions.

Effect Size

One effect size can be calculated from this study using Holmes's method. The cooperative group had an N of 28 with the individualistic group having an N of 27 and a reported F value of 0.50.

$$ES = \sqrt{0.50\ (\frac{1}{28} + \frac{1}{27})} = 0.191$$

The effect size is positive because the cooperative group achieved the higher gains.

Johnson, D.W., Johnson, R.T., & Scott, L. (1978). The effects of cooperative and individualized instruction on student attitudes and achievement. The Journal of Social Psychology, 104, 207-216.

Sample

The sample consisted of 30 white fifth and sixth grade math students. Twelve of the students were male and eighteen were female.

Location and Setting

The study was conducted in an advanced math class for fifth and sixth grade students. The class was

situated in a suburban upper middle class elementary school.

Method

Five months prior to the beginning of the study, the 30 highest achieving math students were placed in an advanced math class. Immediately preceding the study, the students were rank ordered from highest to lowest on the basis of math achievement. The students were then systematically placed in either a cooperative learning condition (STAD) or an individualistic effort condition.

The students studied math for one hour per day for fifty days. The students studied advanced set theory, advanced number theory, and geometry. Students either worked in the cooperative goal structure or in an individualized goal structure. Both conditions worked in the same classroom simultaneously and the students were informed of the study and of the other condition. Cooperative students were given all test individually and then again in groups while individual effort students were given tests individually.

A posttest only control group design was used to conduct the study. Analysis of covariance was used to analyze the data.

Variable

The dependent variable in this study was achievement as measured by three teacher made tests. Only those tests taken individually will be included in the analysis.

Findings

On individually taken tests, the cooperative learning group performed significantly better on set theory problems. On the retention test, the cooperative learning group performed significantly better than did the individual effort students. No findings were reported for the number theory or geometry tests taken individually.

Effect Size

Two effect sizes will be calculated using the Holmes method.

Set Theory. The cooperative group had an N of 16 while the individualistic group had an N of 14. An F value of 3.79 was reported.

$$ES = \sqrt{3.79\left(\frac{1}{16} + \frac{1}{14}\right)} = 0.713$$

The effect size is negative because the individualistic effort group achieved the higher mean posttest score.

Retention test. The cooperative group had an N of 16 while the individualistic group had an N of 14 with a reported F value of 4.92.

$$ES = \sqrt{4.92\left(\frac{1}{16} + \frac{1}{14}\right)} = 0.812$$

The effect size is positive because the cooperative learning group achieved the higher scores.

Mean Effect Size = 0.762

Johnson, L.C. (1985).

The effects of four cooperative learning models on student problem solving achievement in mathematics. (Doctoral Dissertation, University of Houston) Dissertation Abstracts International, 47, 403A.

Sample

The sample consisted of 859 fourth and fifth grade students and their 51 teachers. The cooperative group

had 525 students and 28 teachers. The individualistic group had 23 teachers and 334 students.

Location and Setting

The study was conducted in 10 suburban elementary schools in Houston, Texas. The school district serves mainly middle-class and upper middle-class students.

Method

Students were randomly assigned to classes and teachers were assigned to conditions on the basis of previous training in the STAD cooperative learning model. Teachers in the cooperative group participated in a week long inservice program and received materials to use during the year. They also attended workshops and inservice sessions throughout the year. Teachers in the control group received no inservice training and did not receive additional materials. The study was conducted over one school year.

A pretest-posttest, control group quasi-experimental design was used. Data were analyzed using *t*-tests and multiple regression analysis.

Variable

The variable of interest in this study was problem solving achievement as measured by the Romberg and

Wearne Problem Solving Test. This test was used as both a pretest and a posttest.

Findings

There were statistically significant differences in the mean achievement scores between conditions with the cooperative group showing the greater gains.

Effect Size

One effect size, cooperative learning versus individualistic effort, can be calculated from this study. The cooperative group had an N of 525 while the individualistic group had an N of 334 with a reported F value of 3.65.

$$ES = \sqrt{3.65\left(\frac{1}{525} + \frac{1}{334}\right)} = 0.134$$

The effect size is positive because the cooperative group posted the higher gains.

Martin, J.M. (1986).

The effects of a cooperative, competitive, or combination goal structure on the mathematics performance of black children from extended family backgrounds. (Doctoral dissertation, Howard

University) University Microfilm International,
47, 1173A.

Sample

The sample for this study consisted of 88 black second graders from one elementary school. The subjects were enrolled in three classes which were each taught by one of three black female teachers.

Location and Setting

The study was conducted over eight weeks in a metropolitan Maryland school district. The elementary school served a predominately poor, black population. (the entire second grade population was black and 75% of the school qualified for free lunches under the Chapter I program.)

Method

Those second grade students whose families completed surveys were selected to participate in the study. Intact classes were randomly assigned to one of three conditions: cooperation without intergroup competition, cooperation with intergroup competition (TGT), and competitive. All conditions used the same materials and curriculum.

A pretest-posttest control group design was used and data were analyzed using analysis of covariance.

Variable

The dependent variable of interest in this study was mathematics achievement as measured by the Chicago Mastery Learning (CML) test. The CML was used as both the pretest and posttest.

Findings

The students in the competitive condition had significantly lower gains than students in the two cooperative conditions. There were no significant differences in the mathematics achievement between the two cooperative conditions.

Effect Sizes

Effect size can be calculated for cooperative learning with intergroup competition versus competition using the definitional formula. The cooperative learning group had a mean of 73.60 while the competitive group had a mean of 65.39 with a standard deviation of 19.88.

$$ES = \frac{72.89 - 65.39}{19.88} = 0.3777$$

19.88

The effect size is positive because the cooperative group achieved the higher gains.

Mesch, D., Lew, M., Johnson, D.W., & Johnson, R. (1986).

Components of cooperative Learning: Effects of collaborative skills and academic group contingencies on achievement and mainstreaming. Contemporary Educational Psychology, 11, 229-239.

Sample

The sample consisted of 83 eighth-grade students with 30 students in the individualistic condition, 27 students in the cooperative condition with no intergroup competition, and 26 students in the cooperative condition with intergroup competition (TGT).

Location and Setting

This study was conducted in three eighth-grade mathematics classes from a northeastern, upper-middle-class suburban school district.

Method

All three classes were taught by the same teacher using the same materials. The teacher was trained for

one year in principles of behavior analysis and cooperative learning and had implemented both during the previous school year.

In one class, the teacher taught in a traditional manner with lecture, questions, practice and tests. In the cooperative condition with no intergroup competition, the teacher taught a whole-group lesson, answered questions, allowed time for practice in cooperative groups and then tested individually. In the cooperative learning situation with intergroup competition, the teacher taught a whole-group lesson, assigned students to work in groups on assignments, encouraged group study for tests, tested individually, and then followed with intergroup competition in the form of a tournament pitting one member of each group against others with the same mathematical ability and previous test record.

A 1 x 3 analysis of variance was used to analyze the data among the three 8th grade mathematics classes.

<u>Variable</u>

The dependent variable of interest in this study was mathematics achievement as measured by test

performance. Tests from the mathematics curriculum approved by the school district were used.

Findings

The students in the cooperative learning conditions with intergroup competition performed significantly higher than did the students in either the cooperative condition or the individualistic condition. For the purposes of this meta-analysis, the TGT condition will be compared to the individualistic condition.

Effect Sizes

One effect size will be calculated from this study using the Holmes method.

$$ES = \sqrt{3.53\left(\frac{1}{26} + \frac{1}{30}\right)} = 0.504$$

The effect size is positive because the TGT group achieved higher gains.

Mevarech, Z.R. (1985).

The effects of cooperative mastery learning strategies on mathematics achievement. Journal of Educational Research, 78, 372-377.

Sample

Participants in the study were 134 students who were enrolled in four fifth-grade classes. Approximately 40% of the students were male.

Location and Setting

All the participants in this study attended one school in Israel. The school was a segregated school which served predominantly middle class students from Ramat Gan.

Method

Four fifth-grade classes were taught a fifteen week unit on fractions using the same curriculum materials and the same schedule of instruction. Students were randomly assigned to classes by school administrators and classes were randomly assigned to treatments by the researcher. Students were taught using one of four methods: 1) control, 2) STAD, 3) Mastery Learning Strategies, and 4) Student Team Mastery Learning, a combination of STAD and Mastery Learning Strategies. A pretest-posttest control group experimental design was used to contrast achievement scores. A 2 x 2 multivariate analysis of covariance

and a univariate analysis of variance were used to analyze the data.

Variables

The dependent variables in this study consisted of achievement measured as posttest scores on an objective mathematics test which provided measures of computation achievement and comprehension achievement. A 20-item mathematics test constructed by the researcher was used as pretest. No significant differences existed between the groups on the pretest.

Findings

Analysis of the data indicated that there were no significant differences between the STAD group and the control group in computation or comprehension. When compared with the control group, the mastery learning group and the student team mastery learning group (combination STAD and mastery learning) scored significantly higher in computation and in comprehension.

Effect Sizes

Of the six effect sizes which can be calculated from the data provided in this study, only the effect

sizes from the following will be reported using the definitional formula:

Cooperation (STAD) Versus Individualistic (Computation): The mean score of the cooperative group was 29.1 and the mean score of the individualistic group was 25.1. The standard deviation of the individualistic group was 7.1. This resulted in an effect size of:

$$ES = \frac{29.1 - 25.1}{7.1} = 0.563$$

Since the cooperative group showed higher gains, the effect size is positive.

Cooperation (STAD) Versus Individualistic (Comprehension: The mean score of the cooperative group was 9.8 and the mean score of the individualistic group was 9.2. The standard deviation of the individualistic group was 2.8. This resulted in an effect size of:

$$ES = \frac{9.8 - 9.2}{2.8} = 0.214$$

Since the STAD group showed higher gains, the effect size is positive.

Cooperation (STAD) Versus Mastery Learning (Computation): The STAD group had a mean score of 29.1 and the individualistic group achieved a mean score of 30.6. The standard deviation of the individualistic group was 5.1. This resulted in an effect size of:

$$ES = \frac{29.2 - 30.6}{5.1} = - 0.294$$

As the individualistic group showed higher gains, the effect size is negative.

Cooperation (STAD) Versus Mastery Learning (Comprehension. The cooperative group posted a mean score of 9.8 while the individualistic group had a mean score of 10.6 with a standard deviation of 2.8. The resulting effect size was:

$$ES = \frac{9.8 - 10.6}{2.8} = 0.286$$

As the individualistic group showed higher gains, the effect size is negative.

Cooperation (STAD) Versus the Combination Group (Computation): The STAD group achieved a mean score of 29.2 while the combination group posted a mean

score of 30.6 with a standard deviation of 5.1. This resulted in an effect size of:

$$ES = \frac{29.2 - 30.6}{5.1} = 0.274$$

Since the combination group showed higher gains, the effect size is negative.

<u>Cooperation (STAD) Versus Combination (Comprehension)</u>: The STAD group had a mean score of 10.4 and the combination group mean score was 10.6 with a standard deviation of 2.8. The effect size was calculated to be:

$$ES = \frac{10.4 - 10.6}{2.8} = -0.071$$

Since the combination group showed higher gains, the effect size is negative.

Mean Effect Size: -0.025

Moskowitz, J.M., Malvin, J.H., Schaeffer, G.A. & Schnapps, E. (1983).

Evaluation of a cooperative learning strategy. <u>American Education Research Journal</u>, <u>20</u>, 687-696.

Sample

The sample consisted of 261 fifth and sixth grade students with 147 students in the cooperative group and 114 students in the individualistic group. The cooperative group consisted of 33 fifth grade males, 37 sixth grade males, 38 fifth grade females, and 39 sixth grade females. The individualistic group consisted of 38 fifth grade males, 23 sixth grade males, 39 fifth grade females and 14 sixth grade females.

Location and Setting

This study was conducted in 13 classes in four elementary schools. The schools were located in a suburban, middle class, predominantly white school system in northern California.

Method

Four schools were randomly assigned to become experimental schools and four schools were randomly assigned to become control schools. Teachers in the experimental schools who indicated an interest in the cooperative learning model were also included in the design.

STAD was used for reading and mathematics instruction in the cooperative learning schools for one

year. Control teachers instructed their classes in their usual manner.

A randomized invitation, pretest-posttest, untreated control group, quasi-experimental design was used. A 2 x 2 x 2 analysis of covariance (grade x sex x condition) was performed to analyze the data.

<u>Variable</u>

The dependent variable of interest in this study was mathematics achievement as measured by the Total Mathematics score on the Stanford Achievement Test. The tests were used as both a pretest and as a posttest.

<u>Findings</u>

The researchers found no significant difference in mathematics achievement between the cooperative and individualistic groups.

<u>Effect Size</u>

One effect size will be calculated from this study using the Holmes method. In mathematics achievement, the cooperative group had an N of 147 and the individualistic group had an N of 114 an F value of 1.46.

$$ES = \sqrt{1.46\left(\frac{1}{147} + \frac{1}{114}\right)} = 0.151$$

The effect size is positive because the cooperative group had higher gains than the individualistic group.

Peterson, P.L., Janicki, T.C., & Swing, S.R. (1981). Ability x treatment interaction effects on children's learning in large-group and small group approaches. American Education Research Journal, 18, 453-473.

Sample

The sample consisted of 93 fourth and fifth grade students.

Location and Setting

The study was conducted in four math classes taught by two experienced teachers. The four classes were in one school in rural Wisconsin.

Method

Through stratified random assignment, 93 students were assigned to one of four classes. Two classes were assigned an individualized effort goal structure while the other two were assigned to a cooperative goal structure (STAD).

All students were taught geometry for forty minutes per day for two weeks and both conditions used the same materials and curriculum. Each teacher taught one individualized effort class and one cooperative class. Achievement tests were administered after nine days of instruction and readministered two weeks after the posttest.

A posttest only control group design was used in conducting this study. Data were analyzed using generalized regression analysis.

Variable

The dependent variable of interest was math achievement as measured by a geometry posttest developed by the researchers.

Findings

There were no significant differences on the posttests or retention tests between conditions. However, low and high ability students appeared to perform slightly better in cooperative condition while the medium ability students appeared to perform slightly better in the individualized effort condition.

Effect Sizes

The cooperative group had an N of 48 while the individualized group had an N of 45. An F value of 0.00 was reported. Using the Holmes method, the effect size is as follows:

$$ES = \sqrt{0.00\left(\frac{1}{48} + \frac{1}{45}\right)} = 0.00$$

Ross, J.A., (1988).

Improving mathematics problem solving through cooperative learning. American Education Research Journal, 25, 573-591.

Sample

The subjects for this study were 342 fourth-grade students from 17 intact classes.

Location and Setting

The study was conducted in 17 intact classes from a large school system in central Ontario.

Method

Seventeen intact classes wee randomly assigned to three treatment conditions: Treatment 1 (whole-class method), Treatment 2 (STAD cooperation learning model) and Treatment 3 (traditional). Treatment 1 involved

the whole-class method for teaching problem-solving skills. Teachers were provided highly detailed instructional materials including student worksheets and weekly quizzes.

Treatment 2 followed the STAD procedures. The instructional materials were identical to those used in the whole-class method. In Treatment 3, the control group received a traditional lesson in problem solving. The study was conducted over a ten-week period.

Variable

The dependent variable of interest in this study is mathematics achievement in the area of problem solving. Three versions of the problem-solving instruments were created by the researchers and were administered to the students as pretests and posttests.

Findings

This study found a statistically significant difference for achievement in mathematics between the cooperative learning group and the traditional learning group.

Effect Size

One effect size will be calculated for this study using the definitional formula. The cooperative

learning group had a mean score of 2.41 with a standard deviation of .80.

$$ES = \frac{6.2 - 2.41}{0.8} = 4.74$$

The effect size is positive because the cooperative learning group achieved the higher gains.

Sherman, L.W., & Thomas, M. (1986). Achievement in cooperative versus individualistic goal structured high school classrooms. Journal of Educational Research, 79, 169-172.

Sample

The sample consisted of 38 students who were enrolled in one of two general math high school classes. There was an equal distribution of both genders in both classrooms, and the median age in both classes was 15 years. Students enrolled in these classes were typically low achieving freshmen and sophomores.

Location and Setting

All the students in the study attended a rural midwestern high school serving a predominantly Caucasian population.

Method

Two high school general math classes were differentially taught a 25 day unit of instruction concerned with the computation and interpretation of percentages. One class of twenty students was instructed using the individualistic goal structure while the remaining eighteen students were taught using the cooperative learning model (TGT) with intergroup competition goal structure. The classroom which utilized the individualistic goal structure was normally taught with this method, and the instructor who taught using the cooperative goals structure was trained to use that method. Both instructors volunteered to participate in the comparative study.

An untreated control group, pretest-posttest, quasi-experimental design was used to contrast the achievement scores. A three-way within subjects analysis of variance (subjects x time x treatment) was used to analyze the data.

Variable

The dependent variable in this study consisted of achievement measured as the mean differences of the

groups on a thirty-item teacher-made test. This test was used as both a pretest and as a posttest.

Findings

The analysis of variance indicated that there was a significant interaction between groups ($p < .001$) with the cooperative group showing greater gains. Neither group was significantly different from the other on the pretest.

Effect Size

The cooperative group had an N of 18 and the individualistic group had an N of 20 with an F value of 18.62 reported. The effect size will be determined using the Holmes method:

$$ES = \sqrt{18.62 \left(\frac{1}{18} + \frac{1}{20}\right)} = 1.40$$

Since the cooperative group showed higher gains, the effect size is positive.

Slavin, R.E. (1984).

Team assisted individualization: Cooperative learning and individualized instruction in the mainstreamed classroom. Remedial and Special Education, 5, 33-42.

Experiment One

Sample

The subjects who participated in the first experiment were 504 third, fourth, and fifth grade students. Eighty percent of the students were white, 15% were black, and 5% were Asian-Americans. Six percent of the students were receiving special education services in resource rooms.

Location and Setting

The study was conducted in 18 classes in six elementary schools located in a middle-class suburban Maryland school district.

Method

Schools were randomly assigned to one of three conditions: STAD, Individualized Instruction (II), or an untreated control group. From each school, one third, fourth and fifth-grade class was selected to participate in the study.

The STAD and II groups used the same curriculum and materials with the only differences in instruction being that the STAD group worked in teams and received team recognition and team scores. The control group was taught using traditional methods (traditional texts

and group-paced instruction which was supplemented with small homogeneous teacher directed math groups).

All classes received eight weeks of mathematics instruction and the same amount of time was devoted to mathematics instruction in each condition. Teachers of the STAD and II groups were trained to use the materials while the teachers of the control group used the methods which they normally used.

A pretest-posttest, control group experimental design was used to conduct the study. The data were analyzed through the use of multiple regressions and analysis of covariance.

Variable

The dependent variable for this study was mathematics achievement as measured by gain scores on the Mathematics Computation subscale of the Comprehensive Test of Basic Skills (CTBS). This test was used as both a pretest and a posttest.

Findings

The results of the multiple regressions indicated that there was a marginally significant treatment effect. The analysis of covariance indicated that both the STAD and II groups had higher gains than did the

control group. There was no significant difference between the STAD group and the II group.

Effect Sizes

Two effect sizes will be calculated from this study. The effect sizes will compare the mathematics achievement of STAD versus II and STAD versus the control group.

STAD Versus II. For this calculation, the Holmes method will be used. The cooperative learning group had an N of 138 and the II group had an N of 148 with an F value of < 1 reported. Using the available data, an F value of 0 is estimated.

$$ES = \sqrt{0.00\ (\frac{1}{138} + \frac{1}{148})} = 0.00$$

STAD Versus Control. The cooperative group had an $\underline{N}$ of 138 while the individualistic group had an $\underline{N}$ of 148 and an $\underline{F}$ value of 5.39 was reported. The Holmes method was used to calculate the effect size.

$$ES = \sqrt{5.39\ (\frac{1}{138} + \frac{1}{148})} = 0.275$$

The effect size is positive because the cooperative group posted higher gains.

Mean Effect Size = 0.137

Sample

The sample consisted of 1,371 third, fourth, and fifth grade students. One hundred thirteen (8.2%) students were receiving special education services in resource rooms.

Location and Setting

This study was conducted in 59 classes in eight elementary schools. The schools were located in a suburban Maryland school district.

Method

Teachers in the schools volunteered to use STAD. The teachers in the control group volunteered with the understanding that they would be given training in STAD the following year.

Seven hundred nineteen students in 31 classes in five schools comprised the STAD group while the control group consisted of 652 students in 28 classes in three other schools. The control students were matched on California Achievement Test scores with the experimental group. Fifty control group students and

63 STAD students were receiving special education services. The students received mathematics instruction as described in Experiment I for 24 weeks.

An untreated control group, pretest-posttest quasi-experimental design was used to conduct the study. The data were analyzed through analysis of convariance.

Variable

The dependent variable in this study was math achievement as measured by gains on standardized mathematics tests. The Comprehensive Test of Basic Skills was used as a pretest and the California Achievement Test was used as a posttest.

Findings

The analysis of covariance revealed that there were no pretest differences between groups. The STAD groups showed significantly higher gains than the control group in mathematics achievement.

Effect Sizes

Effect sizes for computations and for concepts and applications will be determined for the full sample using the Holmes method.

The N for the cooperative group (STAD) was 719 while the N for the individualized group (control) was 652.

Computations. The reported F value was 26.05. The calculated effect size is:

$$ES = \sqrt{26.05\left(\frac{1}{719} + \frac{1}{652}\right)} = 0.273$$

The effect size is positive because the cooperative group had higher gains.

Concepts and Applications. The reported F value was 11.46. The effect size equals:

$$ES = \sqrt{11.46\left(\frac{1}{719} + \frac{1}{652}\right)} = 0.183$$

The effect size is positive because the cooperative group posted higher gains.

Mean Effect Size: 0.229

Slavin, R.E., & Karweit, N.L. (1981). Cognitive and affective outcomes of an intensive student team learning experience. Journal of Experimental Education, 50, 29-35.

Sample

The sample consisted of 456 fourth and fifth grade students in six schools and their 20 teachers.

Location and Setting

The study was conducted in six elementary schools in a rural Maryland school district over one semester. The six schools were constructed as open schools but classes were structured as traditional classes. Students changed classes for the purpose of homogenous grouping for at least reading and most often for both reading and math.

Method

Ten teachers in two schools were assigned to the experimental group and ten additional teachers in four schools were assigned to the control group. Teachers in the control group were instructed to teach in their usual manner while the teachers in the experimental group were instructed to use cooperative learning strategies.

In the experimental group, the teachers used STAD for all their language arts instruction and TGT for all their mathematics instruction. Students were usually on different teams for mathematics and language arts.

A pretest-posttest, quasi-experimental design with an untreated control group was used. Analysis of covariance was used to analyze the data.

Variable

The achievement dependent variables for this study were reading vocabulary; reading comprehension; language mechanics; language expression; mathematics computation; and mathematics concepts and application. The Comprehension Test of Basic Skills (CTBS) was used as both the pretest and posttest with Form S being used as the pretest and Form T being used as the posttest.

Findings

The cooperative group scored significantly higher than the traditional group on three of the seven CTBS subtests. However, for the purposes of this meta-analysis, only mathematics computation and mathematics concepts and application will be discussed. There were no significant differences found between groups on the mathematics computation and mathematics concepts and application subtests. Although the difference between the two groups was not significant, the experimental group had higher pretest means on every mathematics subtest.

Effect Sizes

Effect sizes were computed for all subtests using the Holmes method. The study did not include enough information to calculate the effect size on mathematics computation so the F value was estimated from available data and effect sizes were calculated using the Holmes method. All cooperative groups used a cooperation with intergroup competition goal structure while the non-cooperative groups utilized an individualistic goal structure.

Mathematics Concepts and Applications Effect Sizes. The cooperative group had an N of 209 and the individualistic group had a N of 166 with an F value of 1.95

$$ES = \sqrt{1.95\left(\frac{1}{209} + \frac{1}{266}\right)} = 0.145$$

Mathematics Computation Effect Size. The cooperative group had an N of 206 and the individualistic group had an N of 162 with an estimated F value of 0.

$$ES = \sqrt{0.00\ (\frac{1}{206} + \frac{1}{162})} = 0.00$$

Mean Effect Size = -0.072

Talmage, H., Pascarelle, E.T., & Ford, S. (1984). The influence of cooperative learning strategies on teacher practices, student perceptions of the learning environment, and academic achievement. American Education Research Journal, 21, 163-179.

Sample

The sample consisted of 592 students in grades two through six. The students were taught by 17 teachers in 17 schools. In tact classes were used and 12 schools contained both experimental and control classes while five schools contained only control classes.

Location and Setting

All of the students attended suburban elementary schools within the Chicago metropolitan area.

Method

Twelve schools in the district were designated as participating schools. Thirty-two teachers were selected for the experimental group, and nineteen were

selected for the control group. All teachers taught mathematics to their own intact classes. The teachers involved in the cooperative learning model were trained in TGT strategies.

An untreated control group, pretest-posttest, quasi-experimental design was used. Analysis of covariance and regression analysis were used to analyze the data.

Variable

The dependent variable in this study consisted of math achievement measured as the mean differences between the control and experimental groups on standardized tests published by Science Research Associate, Inc. The tests were used as both a pretest and a posttest and were administered in the spring of 1981 and 1982.

Findings

The analysis of covariance indicated that there was a significant difference in mathematics achievement between the cooperative and non-cooperative groups with the cooperative group showing higher gains. No difference existed between the groups on the pretest.

Effect Size

The TGT group's adjusted mean posttest score was 293.69 while the control group posted an adjusted mean score of 282.29 with a standard deviation of 62.29. The effect size will be calculated directly from the definitional formula.

$$ES = \frac{293.69 - 282.29}{62.29} = 0.183$$

The effect size is positive since the cooperative group (TGT) achieved higher gains than did the non-cooperative group (individualistic effort).

Yager, S., Johnson, R.T., Johnson, D.W., & Snider, B. (1986).

The impact of group processing on achievement in cooperative learning groups. Journal of Social Psychology, 126, 389-397.

Sample

The sample consisted of 84 third-grade students.

Location and Setting

The third-graders were middle-class students from a midwestern school district. Forty-four males and forty females took part in the study.

Method

Students were randomly assigned to conditions stratifying for sex and ability. Twenty-eight students were assigned to each condition: the cooperative condition (TGT) and the individualistic condition.

Students in each condition were together for 35 minutes each day for instruction. The content of the lesson consisted of a mathematics unit that is required by the school district for the third grade. After 12 sessions, all students were given mid-unit achievement tests.

A 3 x 3 analysis of variance was conducted to determine the differences among conditions.

Variable

The dependent variable was student achievement in mathematics as measured by a test prepared by the researchers. The tests were constructed by the researchers to measure factual recognition of the concepts and principles in the unit.

Findings

Students in the TGT group achieved higher gains in mathematics achievement than did the individualistic group.

Effect Size

One effect size was computed for this study using the Holmes method. The TGT group had an N of 28 while the individualistic group had an N 28 with an F calculated to be 11.31.

$$ES = \sqrt{11.31 \left(\frac{1}{28} + \frac{1}{28}\right)} = 0.898$$

The effect size is positive because the TGT group showed greater mathematics gains than the individualistic group.

This chapter has provided a description of the criteria used for selecting the studies and brief summaries of the studies included in the meta-analysis.

Chapter 4

Analysis of Data

This chapter provides an analysis of the studies reviewed in Chapter 3. The studies were reviewed using a format which included the sample, location an setting, method (including method of analysis), variables, and findings. Those studies which provided enough information for the calculation of effect size had effect sizes calculated in Chapter 3 also.

All studies reviewed in Chapter 3 were first analyzed through the use of a vote table (Table 2). The studies in the vote table were organized according to the cooperative learning structure--TGT studies and STAD studies. Following the analysis of the vote table, the chapter provides a thorough analysis of effect sizes and mean effect sizes. A discussion of the results follows the analysis of effect sizes.

Vote Analysis

Table 2 lists 19 studies and 33 conclusions developed by the original authors. The studies' conclusions in the vote table are separated into three categories: (a) significant positive, where the cooperative goal structure achieved statistically

significant higher gains, (b) significant negative, where the traditional goal structure achieved statistically significant higher gains, and (c) no significant difference, where neither the cooperative goal structure nor the traditional goal structure achieved statistically significant higher gains. In the column labeled "no significant difference," "0" indicates no discernible difference, "+" indicates statistically nonsignificant gains by the cooperative group, and "-" indicates statistically nonsignificant gains by the traditional group.

Thirteen conclusions in the TGT column of the vote table indicate statistically significant greater gains by this cooperative learning method, and three conclusions indicate statistically nonsignificant gains. In the STAD column, five conclusions indicate statistically significant greater gains by this cooperative learning method, six conclusions indicate no statistically significant difference between the STAD method and the traditional learning method, and conclusions indicate statistically significant greater gains made by the traditional group.

The TGT studies, with 81% statistically significant positive studies and 19% indicating no significant difference, is declared to be more effective in increasing mathematics achievement than the STAD cooperative learning studies, according to the vote table.

Table 2

Vote Table

		TGT Studies		
	Opposing Goal	Significance		
Author	Structure	Positive	None	Negative
Edwards	Ind.	X		
		X		
		X		
Gabbert	Ind.	X		
		X		
		X		
Goldberg	Ind.	X		
Gordon	Ind.		X(+)	
Martin	Comp.	X		

TGT Studies

Author	Opposing Goal Structure	Significance: Positive	None	Negative
Mesch	Ind.	X		
Sherman	Ind.	X		
Slavin, '81	Comp.		X(+)	
			X(O)	
Talmage	Comp.	X		
Yager	Ind.	X		
Glassman	Comp.		X(-)	
Johnson,D.	Ind.	X		
		X		
Johnson,L.	Comp.	X		
Mevarech	Ind.	X		X
		X		
				X
				X
			X(-)	
Moskowitz	Comp.		X(+)	
Peterson	Ind.		X(O)	

		TGT Studies		
	Opposing Goal	Significance		
Author	Structure	Positive	None	Negative
Ross	Comp.	X		
Slavin,'84	Ind.		X(O)	
		X		
Slavin,'84	Ind.	X		
		X		

The STAD record shows 53% statistically significant positive studies, 3% negative studies, and 29% studies indicating no statistically significant difference between the STAD method and a traditional learning method in achieving higher gains in mathematics.

Meta-analysis

Nineteen studies were identified in Chapter 3 as having met the selection criteria and effect sizes were calculated for those studies. Thirty-three conclusions were calculated from the 19 studies yielding a mean per study of 0.537. A mean effect size of 0.537 indicates

that students taught using a cooperative goal structure, either TGT or STAD, reported an average effect size of 0.537 when compared with the effect sizes of groups of students taught using a traditional goal structure.

Table 3 shows the comparison of the two cooperative learning models with regard to the conclusions of the studies, the direction of significance, existence of nonsignificance, total effect sizes and mean effect sizes.

Table 3

TGT and STAD Effect Sizes

Comparison Categories	TGT	STAD	Total
Number of studies	10	9	19
Number of conclusions	16	27	33
Number of positive results	13	9	22
Percentage positive results	81%	53%	66%
Number of negative results	0	3	3
Percentage negative results	0%	18%	18%
No. of nonsignificant results	3	5	8
Percentage nonsign. results	19%	29%	48%
Total effect sizes	10.634	7.115	17.749
Mean effect size	0.665	0.418	0.537

Note. The number of positive results indicates the winner of the vote table, Table 2.

A pictorial representation may aid in understanding the relationship of the scores yielded by the TGT studies and those yielded by the STAD studies. Chart 1 shows the overlapping distributions. TGT studies are represented by asterisks and a solid line; STAD studies are represented by lowercase "x's" and a dotted line.

CHART 1

TGT and STAD Scores Plotted

```
          6
Number    5                            x*
  of      4                                    *
Studies   3                        x       x*
          2                          x*     x
          1                        * x    *           x
          0     -3     -2     -1     0     1     2    3
                              Z  Scores
```

The similarity in the mean effect sizes of the TGT studies (0.665) and the STAD studies (0.418) results in their similar placement on the Z score axis. Pictorially, the TGT and STAD test results appear to be more alike than different.

Comparisons of effect sizes by goal structures. Effect sizes may be grouped according to goal structure. The mean effect size for the TGT studies when compared with individualistic goal structures was 0.834 as indicated on Table 4. This indicates that, when compared with the academic performance of groups taught mathematics using an individualistic goal structure, students taught using the TGT cooperative learning method gained an average of 0.834 of a standard deviation more. When compared with a competitive goal structure, students included in the TGT model gained an average effect size of 0.158 in mathematics achievement. Thirteen effect sizes were calculated from studies comparing the STAD cooperative learning model and an individualistic goal structure. This calculation indicates that the groups of students using the STAD model achieved an effect of 0.205 when compared with students using the individualistic goal structure. When compared with competitive goal structures, the STAD model achieved an effect size of 1.251.

When the TGT model is compared to both individualistic and competitive goal structures (more

traditional goal structures), the result is that students included in TGT achieve an effect size of 0.665.

Table 4

Mean Effect Size

Overall and By Goal Structure

Comparisons	#ES	ES
TGT vs. Individual.	12	0.834
TGT vs. Competitive	4	0.158
TGT vs. Both Goal Struc.	16	0.665
STAD vs. Individualistic	13	0.205
STAD vs. Competitive	4	1.251
TGT + STAD vs. Individ.	25	0.506
TGT + STAD vs. Compet.	8	0.705
TGT + STAD vs. Both Goal/ Structures	33	0.537

When both TGT and STAD cooperative learning models are compared with more traditional goal structures, individualistic and competitive, the results indicate that students involved in the cooperative learning models achieve an effect size of 0.537.

When TGT is compared with both goal structures, the result is an achievement of the cooperative groups of students with an effect size of 0.665. Students using the STAD cooperative learning model in comparison with students in traditional goal structures resulted in an effect size of 0.418 in mathematics achievement.

Comparison of effect size by grade level. Mean effect sizes which compared TGT and STAD with traditional goal structures were calculated for elementary, middle school and high school students. As indicated in Table 5, the elementary school students using the TGT cooperative learning model achieved an effect size of 1.117 when compared to elementary students involved in an individualistic goal structure. Students using the STAD cooperative learning model achieved an effect size of 0.162 when compared with students involved in an individualistic goal structure.

Elementary students in TGT groups achieved an effect size of 0.158 when compared with students in competitive goal structures. Elementary students in STAD groups achieved an effect size of 1.251 when compared with students in competitive goal structures.

Although most cooperative learning studies have been conducted at the elementary level, results from the middle school show that TGT groups report an effect size of 0.502 in mathematics achievement when compared with students in individualistic goal structures. High school students in TGT groups, with the greatest mathematics achievement gains of all, reported an effect size of 1.40 when compared with students in individualistic goal structures.

No studies existed for middle and high school students comparing the STAD cooperative learning model with either an individualistic or competitive goal structure for mathematics achievement. No studies existed for middle and high school students comparing the TGT cooperative learning model with a competitive goal structure for mathematics achievement.

Comparisons of effect sizes by length of study. The duration of the studies ranged from two weeks to one school year (36 weeks), and since this is a wide range, the data were analyzed to determine if the length of the study impacted on the effect size.

A Pearson product-moment correlation was performed to determine if a relationship existed between the

Table 5

Mean Effect Size by Grade Levels

Grade Levels	TGT vs. Individualistic	STAD vs. Individualistic
Elementary School	1.117	.162
Middle School	0.502	
High School	1.40	
	TGT vs. Competitive	**STAD vs. Competitive**
Elementary	.158	1.251
Middle School		
High School		

length of the studies and the effect sizes. The length of the study was correlated with the mean effect size for each study. The correlation coefficient was 0.203 for the TGT studies. The critical value at a = 0.05, two-tailed test when N=16 is (0.456 + 0.399) /2 = 0.427, so the correlation between the length of the study and increase in effect size in TGT studies is not

statistically significant. The correlation coefficient was -0.337 for STAD studies. The critical value at a + 0.05, two-tailed test, when N = 17 is (0.425 + 0.399)/2 = 0.412 so the correlation between length of study and increase in effect size in STAD studies is not significant. When low correlations are found, a frequent conclusion is that there is little or no relationship between the two variables under study. However, it must be remembered that the Pearson *r* reflects only the linear relationship between to variables. The failure to find evidence of a relationship may be due to one of two possibilities: a) the variables are in fact unrelated, or b) the variables are related in a nonlinear fashion. Scores and time lengths are related in a linear fashion, so the low correlation rate appears to be a true picture.

The mean length of TGT studies was 12 weeks and for STAD studies was 17 weeks. Keeping in mind the correlation coefficient of .20 for the TGT studies and -.34 for the STAD studies, this would indicate that as the length of the study increased, the mean effect size decreased.

Examining the impact of the length of the study on the effect size further, it was determined that the median length for TGT studies was 13 weeks and the median length for STAD studies was 15 weeks. Table 6 shows the comparison of the mean effect size of TGT studies 12 weeks or less in duration with studies 13 weeks or longer in duration; it also shows the comparison of STAD studies 14 weeks or less in duration with those 15 weeks or longer in duration. Six studies yielding 8 conclusions of TGT studies of 12 weeks or less resulted in a mean effect size of .496. In four studies with 8 conclusions of 13 weeks or longer in duration, the mean effect size was .833. As use of the TGT cooperative learning model increased in duration, the mean effect size increased as well.

In four STAD studies with six conclusions lasting 14 weeks or less, the mean effect size was 1.09. In 5 studies with 11 conclusions of STAD studies lasting 15 weeks or greater, the mean effect size was .053. As the length of the STAD study increased, the mean effect size decreased.

Table 6

Comparing Mean Effect Sizes and Duration of Study

TGT	STAD
12 weeks or less = 0.496	14 weeks or less = 1.09
13 weeks or longer = 0.833	15 weeks or longer = 0.53

Comparisons of effect sizes by location of study. The nineteen studies included in the meta-analysis were examined to determine where they had been conducted in order to determine the generalizability of the results. All the geographic regions of the United States were represented. Two studies were conducted in urban cities in Canada and one in a suburb of a city in Israel.

Table 7 examines the comparative mean effect sizes of TGT and STAD studies conducted in urban, suburban, and rural areas. In urban areas, TGT studies yielded a mean effect size of 0.665 while STAD studies yielded a mean effect of 4.74. In suburban areas TGT studies yielded a mean effect of 0.675; STAD studies conducted

in suburban areas resulted in a mean effect size of 0.232.

TGT studies conducted in rural areas resulted in a mean effect size of 0.554; STAD studies conducted in rural areas resulted in a mean effect size of 0.012. These results indicate that TGT studies yield moderately positive effect sizes in all areas. STAD studies appear to yield extremely positive effect sizes in urban areas and only somewhat positive results in suburban and rural areas.

Table 7

Comparing Mean Effect Sizes

Studies in Urban, Suburban, and Rural Areas

Location	TGT	STAD
Urban	0.665	4.74
Suburban	0.675	0.232
Rural	0.554	0.012

Table 8 presents the location, sample size, and mean effect size for each study.

Table 8

Location, Sample Size, and Mean Effect Size of the Study

Study	Location	Sample Size	Effect Size
Edwards, et al	Urban US	96	0.467
Gabbert, et al	Suburban Midwest	52	1.340
Glassman	Suburban NY	959	0.021
Goldberg	Urban Northeast	47	0.919
Gordon	Urban Canada	55	0.191
Johnson, et al	Suburban US	30	0.762
Johnson, L.C.	Suburban TX	859	0.134
Martin	Urban MD	88	0.377
Mesch	Suburban Northeast	83	0.504
Moskowitz, et al	Suburban CA	261	0.151
Peterson, et al	Rural WI	93	0.000
Ross	Urban Ontario	342	4.740
Sherman, et al	Rural Midwest	38	1.400
Slavin, et al	Suburban MD	504	0.137
Slavin, et al	Suburban MD	1,371	0.229
Slavin, et al	Rural MD	456	0.072
Talmage, et al	Suburban Chicago	592	0.183
Yager, et al	Urban Midwest	84	0.898

Six thousand, one hundred forty-four students participated in 19 studies with 33 conclusions. The sample size of the studies ranged from 30 students to 1,371 students with a mean sample size of 323 students.

Classifying mean effect sizes. Table 9 tallies the mean effect sizes from all the comparisons above, rating 0.2 as a *small* mean effect size, 0.5 as a *medium* mean effect size, and 0.8 as a *large* mean effect size.

Table 9

Comparison of Mean Effect Sizes

	Mean Effect Sizes		
	Small	Medium	Large
Total Mean Effect Size	STAD	TGT	
Versus Individualistic	STAD	TGT	
Versus Competitive	TGT		STAD
Versus Ind. and Comp.	STAD	TGT	
Elementary (vs. Ind.)	STAD		TGT
Elementary (vs. Comp.)	TGT		STAD
Urban Areas		TGT	STAD
Suburban Areas	STAD	TGT	
Rural Areas	STAD	TGT	

A tally of Table 9 shows that TGT studies scored large mean effect sizes in 2 categories and STAD studies scored large mean effect sizes in 3 categories. TGT studies earned 5 medium mean effect sizes to STAD studies' zero. TGT studies garnered 2 small mean effect sizes as compared to 6 garnered by the STAD studies.

CHAPTER 5

Conclusions and Recommendations

Cooperative learning is an instructional strategy which involves heterogeneous groups of four or five students working together to reach a common goal. Activities are designed for interdependence, and students are encouraged to help one another learn. Because students must interact to work toward common goals, supporters of cooperative learning believe that this instructional strategy reduces the alienation at-risk students feel in a hostile urban environment, ensures students an adequate level of basic skills, provides a means of introducing higher level skills into the curriculum, offers an avenue for mainstreaming academically handicapped students, and gives students the collaborative skills necessary to succeed in an increasingly interdependent society.

Purpose of the study

The purpose of the study was to determine which of two cooperative learning models was the most effective in increasing achievement in mathematics for students in grades K-12. The specific objectives of the study were as follows: (a) to select studies which employed

either the TGT or STAD cooperative learning model for learning mathematics in grades K-12, (b) to analyze statistically the studies using meta-analytic techniques, and (c) to reach a conclusion which will impact on educational decision-making.

Controversies exist in the literature on cooperative learning. Research has shown that there are no differences in achievement between students using cooperative methods and those using individualistic methods. Other researchers avow that pure cooperation provides for higher academic gains than do individualistic efforts. Still other researchers have conducted studies which yielded results showing that interpersonal competition is the most effective goal structure.

Researchers who espouse the theories of cooperative learning and who are leaders in the field are in disagreement over which cooperative learning structure is the most effective for raising levels of academic achievement. A major question surrounds the use of group competition in conjunction with cooperative learning. One of the cooperative learning methods under study in this meta-analysis is TGT,

Teams-Games-Tournaments, which offers tournament prizes for student group representatives who win academic tournaments. The other cooperative learning method under scrutiny here is STAD, Student Teams-Achievement Divisions, which typically has students working to help each other learn necessary material but requires them to be tested individually. Researchers disagree as to the use of group competition in cooperative learning methods; one states that using competition in cooperative learning makes the method more competitive than cooperative; another states that the intergroup competition is the factor responsible for increased achievement.

Evidence can be found in the literature which supports all positions regarding the effectiveness of using cooperative learning methods to provide for increased academic achievement. This meta-analysis is aimed at providing a necessary addition to the existing body of research.

Hypothesis

The hypothetical question posed for testing in this meta-analysis concerned a general conclusion regarding the relative effectiveness of two cooperative

learning models, TGT and STAD, in raising the achievement level of mathematics students in grades K-12. A meta-analysis is a statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings. Results of a meta-analysis clarify a previously mixed set of results and allow fairly specific conclusions.

Criteria for selection of the studies

Nineteen studies with 33 conclusions were selected according to the following criteria: (a) the study involved the use of either TGT or STAD as a cooperative learning model; (b) the study compared the cooperative learning model to a pure cooperative model, to an interpersonal competition model, or to an individualistic model; (c) students in grades K-12 participated; (d) students were tested for achievement in mathematics; and (e) the study was conducted in a public school.

Methodology

Studies were reviewed using a format that described the sample, location and setting, method (including statistical analysis), variable, findings, and effect size. An effect size (ES), for the purpose

of this study, is the mean difference of academic achievement in math between the students taught under a cooperative learning condition (x_c) and students taught under traditional competitive, individualistic, or purely cooperative methods (x_t) divided by the standard deviation of the traditional group (s_t).

Summary of Meta-analysis Results

Vote table. Studies were listed on a vote table showing their results as (a) statistically significant positive, where the cooperative learning method was more effective in raising the mathematics achievement level than a more traditional instructional method; b) statistically significant negative, where the more traditional instructional method was more effective in raising the mathematics achievement level; and c) statistically nonsignificant, where neither the cooperative learning method nor the more traditional instructional strategy was more effective. Winning by a simple plurality, the TGT cooperative learning method garnered 81% statistically significant positive studies as opposed to the STAD cooperative learning method with 53% statistically significant positive studies. Using a vote table as a measure, the TGT cooperative learning

model is more effective in raising the mathematics achievement level of students in grades K-12 than the STAD cooperative learning model. Other measures of relative effectiveness to be discussed do not clearly support the TGT cooperative learning model as the most effective method for raising mathematics achievement in students grades K-12.

Effect Sizes. Cohen (1977) provides rough guidelines of 0.2 as a small effect, 0.5 as a medium effect, and 0.8 as a large effect. Interestingly, a 0.5 standard deviation improvement in achievement scores is considered to be a conventional measure of practical significance (Rossi and Wright, 1977). Similarly, the National Institute of Education's Joint Dissemination Review Panel observed that usually one-third (0.33 sdx), but at times as small as one-fourth (0.25 sdx), standard deviation improvement is considered to be educationally significant (Tallmadge, 1977). For the purposes of this meta-analysis, effect sizes were reported and discussed in terms of a 0.2 effect size as *small*, a 0.5 effect size as *medium*, and a 0.8 effect size as *large*.

Comparing mean effect sizes. The mean effect size from TGT and STAD studies as compared with traditional methods of instruction was medium (0.537) and constitutes practical educational significance. The TGT mean effect size is classed as medium (0.665) and the STAD mean effect size is classed as small (0.418). Using this measure, it can be concluded that the TGT cooperative learning model, when compared with the STAD cooperative learning model for relative effectiveness in raising the mathematics achievement level of students in grades K-12, is more effective.

Comparing mean effect sizes by goal structure. Comparing the mean effect size according to goal structure reveals that when the TGT cooperative learning method is compared to an individualistic goal structure in the area of mathematics achievement, the result is a large positive mean effect size favoring the TGT model. However, the TGT is compared to a competitive goal structure in mathematics achievement, the result is a small positive mean effect size. When STAD is compared with an individualistic goal structure in mathematics achievement the result is a small positive mean effect size. Comparing STAD to a

competitive goal structure resulted in a large positive mean effect size.

It can be concluded from the above comparisons that teachers who routinely employ an individualistic goal structure (students learning alone and competing only with themselves) may consider the TGT cooperative learning model for its effectiveness when teaching mathematics. Conversely, teachers who currently employ a competitive goal structure in their mathematics classes could see small benefits from a TGT cooperative learning goal structure.

The STAD cooperative learning model, when compared with a competitive goal structure resulted in a large positive mean effect size (1.251) but a small positive mean effect when compared with an individualistic goal structure. Teachers who regularly use a competitive goal structure in their mathematics classes could, using the STAD cooperative learning model, bolster mathematics achievement scores. Compared with an individualistic goal structure, the results are not as impressive for the STAD cooperative learning model which rated a small positive mean effect size.

Comparing mean effect sizes by grade levels. Mean effect sizes by grade levels were tallied showing that the majority of studies (13) were conducted in elementary schools, 4 in middle schools, and 2 in high schools. No studies existed comparing either TGT or STAD methods in mathematics with a competitive goal structure at middle school or high school level. No studies existed comparing the STAD model with an individualistic goal structure at the middle school or high school level. At the elementary level, the TGT model showed the largest mean effect size (1.117) when compared to an individualistic goal structure; the STAD model reported an even larger effect size when compared with a competitive goal structure (1.251). The TGT model also appeared to be effective at middle school levels with a medium mean effect size and at high school levels with a large mean effect size when compared to an individualistic goal structure.

Educationally significant scores at the middle school and high school level indicate that cooperative learning techniques are effective in mathematics classes at these levels.

Comparing mean effect sizes by length of study. Studies in the meta-analysis ranged in length from 2 weeks to 36 weeks. A Pearson product-moment correlation was performed to determine if a relationship existed between the length of the studies and their mean effect size. The correlation coefficient was 0.203 for TGT studies and -0.337 for STAD studies. Neither coefficient is statistically significant. These figures indicate that, for TGT studies, there is a slight but statistically insignificant correlation between the length of the study and an increase in the positive direction of effect size. For STAD studies, the figure indicates that there is a slight but statistically insignificant correlation in the opposite direction; that is, as the length of the STAD study increased, the mean effect size decreased.

The correlational data are upheld when effect sizes were compared using the median lengths of TGT and STAD studies as a dividing point between shorter and longer studies and their relative mean effect sizes. Shorter TGT studies resulted in a medium mean effect size but increased to a large mean effect size as the

length of the study increased. Shorter STAD studies resulted in a large mean effect size which decreased to a small mean effect size in longer studies.

Comparing mean effect sizes by location of study. TGT studies in urban areas yielded a medium mean effect size as compared to the STAD studies' small mean effect size. In suburban areas, TGT studies garnered a medium mean effect size as compared to a small mean effect size for STAD studies. In rural areas, TGT studies yielded a medium mean effect size as compared to the STAD studies' small mean effect size. Both cooperative learning models earned educationally significant effect sizes for the studies conducted in urban areas. TGT studies performed in suburban and rural areas both earned medium mean effect sizes. It appears that students in all geographic locations respond to cooperative learning methods. Perhaps in suburban and urban areas, the added incentive of winning a tangible prize boosted achievement scores.

This meta-analysis supports the findings of Colton & Cook (1982); McGlynn (1982) and Slavin (1983) whose research indicated that cooperative learning with intergroup competition was more effective. Totalling

the effect sizes of both TGT and STAD studies resulted in a 0.537 effect size (medium) when compared with either an individualistic or a competitive goal structure.

The meta-analysis also supports Michaels' (1977) research which found that interpersonal competition is the most effective goal structure. Very small mean effect sizes were noted in TGT studies opposing a competitive goal structure and in STAD studies opposing an individualistic goal structure.

Although the TGT model appears to be the winner, a number of conflicting results and overlapping of scores indicate that the two models, TGT and STAD, are more alike in their effectiveness than they are different. This finding supports Sharan's (1980) contradictory conclusions regarding the efficacy of different goal structures.

The increased energy expended and increased mathematics achievement shown by participants in TGT studies is probably due to motivation (Gage & Berliner, 1984; Gagne, 1965; Gagne & Merrill, 1990). Valued prizes are powerful incentives for students; stickers, pencils, free time, an extra library visit, a

congratulatory note to take home, a paperback book, or an eraser are all motivators for students.

Since the tournament and awarding of a prize are the only activities which make the TGT model different from the STAD model, these activities may appeal to the need for acquisition which Murray (1938) lists as affecting students' work habits.

Discussion and Implications

Problems and limitations. One of the problems encountered in the meta-analysis was the scarcity of studies in mathematics using cooperative learning methods. Although the number of studies was adequate for meta-analysis, conclusions could be strengthened with the addition of numerous study findings.

Only six of the studies noted the numbers of male and females in the sample; in those six, there was no corresponding test data. A significant comparison could involve the mathematics achievement scores of males and females participating in a cooperative learning model.

Seven studies noted the ethnicity of members of the sample; of those seven, none indicated corresponding test data. In light of the current

descriptions of typical at-risk students, information concerning how students from differing ethnicities perform in a cooperative learning model and mathematics would be enlightening.

Three studies referred to the ability levels of the students comprising the sample. Teachers of considerable number of at-risk students would welcome the conclusive evidence that a specific cooperative learning method could spark interest and boost achievement in mathematics.

Practical implications. A number of findings derived from the study may have practical implications for others involved in research or applied practice in the area. Of the 33 conclusions reached int he 19 studies in the meta-analysis, 22 were statistically significant in a positive direction in favor of the cooperative learning model and mathematics achievement. Mathematics teachers should look upon cooperative learning models as a tool by which to grab an hold their students' attention, an avenue by which to reach an objective, and a change of pace for students tired of a lecture-discussion-assignment format.

Teachers of mathematics at all levels K-12 can try either of these cooperative learning models at no cost. Materials abound on cooperative learning strategies, and TGT and STAD are among the most popular. Prizes can be in the form of free time, extra library periods, or fist in line for lunch--all of which cost nothing.

The TGT model, for teachers in urban and suburban areas, has a tournament and prize which spur sluggish learners to try harder. Students drilling each other on basic mathematics facts becomes a game in itself and one they like to play, especially when there is a prize to be won if everyone knows the facts well.

Efforts should be made to increase the use of cooperative learning models in middle school and high school level mathematics classes where educationally significant gains can be made. Although cooperative learning methods may not be suitable for all topics in a mathematics class, certain topics lend themselves well to cooperative learning techniques: fractions, decimals, percents, problem solving, set theory, number theory, and geometry.

Recommendations for Further Research

Additional research is needed in the area of cooperative learning comparing models for their effectiveness in raising academic achievement levels for students grades K-12. Most studies involving cooperative learning model have been conducted at the elementary level. Studies at the middle school level and beyond are needed to determine the effectiveness of cooperative learning models with older students.

Research is needed to determine if gender, socio-economic level or ethnicity affect mathematics achievement of students participating in a cooperative learning model. In light of the research concerning at-risk students, studies comparing at-risk students using different cooperative learning models to master a specific concept may yield results which impact educational decisions.

Future studies should concentrate on the length of teacher training and its effect on levels of student achievement. Researchers should begin to clearly define what constitutes teacher training for the purposes of replication.

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