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# Cooperative Learning and its Relationship to Motivation and Achievement When Working Math Lab Problems in Principles of Technology

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## Abstract

Working together in a dynamic group process has been shown to be highly effective in maximizing learning outcomes and helping students realize greater academic and social skills (Glasser, 1986). A great deal of research has been conducted on the relationship of cooperative, competitive, and individualistic efforts and instructional methods (Johnson, Johnson & Holubec, 1988). Johnson and his associates in 1981 (as cited by Wood, 1987) revealed that instruction focusing on cooperation and collaboration resulted in significant gains in achievement, self-esteem and social development. Many viable and successful forms and hundreds of thousands of enthusiastic adherents have realized extraordinary successes using cooperative learning (Slavin, 1989). Sharan and Pepitone, both in 1980 (as cited by Wood, 1987) explored the differential effects on students' attitudes, achievement and ethnic relations in cooperative learning. Without a doubt, cooperative learning has become one of the promising options for the future of education.

Although a great deal of research has been done which documents the positive effects of cooperative learning at the primary and secondary levels, very little research has been done to document the effects of cooperative learning in the industrial technology classroom. One purpose of this study was to review the literature and draw conclusions as to how cooperative learning can be used to enhance student motivation and achievement in a principles of technology course.

In the typical classroom of today, each student works alone. This approach is totally contrary to one of the basic human needs to belong to something or someone. The idea of having students function as a group to produce some result has been carefully studied and it works (Glasser, 1986). Students working together in groups such as band, chorus, school newspaper, yearbook, and athletics, have traditionally been successful. The tradition of using the group process in industrial technology (Maley, 1966) can perhaps be even further enhanced in the principles of technology course by incorporating cooperative structures which have been shown to be effective elsewhere in the curriculum. An important purpose of this study will be to provide a means for principles of technology instructors to develop an instructional method which will enhance the course.

# COOPERATIVE LEARNING AND ITS RELATIONSHIP TO MOTIVATION AND ACHIEVEMENT WHEN WORKING MATH LAB PROBLEMS IN PRINCIPLES OF TECHNOLOGY

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# CHAPTER 1

## COOPERATIVE LEARNING AND ITS RELATIONSHIP TO MOTIVATION AND ACHIEVEMENT WHEN WORKING MATH LAB PROBLEMS IN PRINCIPLES OF TECHNOLOGY

Technological advances have drastically changed the equipment and methods for a growing number of fields including manufacturing, construction, energy production, information management, health care, agriculture, transportation, and a host of high technology areas. Technology will continue to create new jobs and will eliminate or modify many others. Vocational education students are now being forced to learn technical concepts involving a broad understanding of the principles governing an array of high technology systems and devices.

A high school course which has been developed to meet the needs of industrial technology students is principles of technology (Pendrotti, 1984). It is an applied science and mathematics for industrial technology or vocational education students in the tenth through twelfth grades. PT is an extensive 2-year curriculum covering fourteen units in applied physics to show how a technical concept can be analyzed and applied to equipment and devices in mechanical, fluid, electrical and thermal energy systems (Pendrotti, 1984).

The educational reform movement in the United States has created pressure from academic proponents to reexamine vocational education policies. Schools are experimenting with new teaching methods that integrate basic academics and hands-on learning (Perry, 1989). Concerned educators have always sought methods to improve student achievement. With higher demands being placed upon students to internalize scientific and mathematical concepts, a need has arisen for a new approach to classroom teaching. Since the early 1970s, researchers have been studying and researching this very problem. Cooperative learning methods have been developed by educators to have students work in small groups to improve achievement (Newmann & Thompson, 1987). The synthesis developed in this research provides the information for principles of technology instructors to utilize cooperative learning methods to increase student achievement when teaching math lab problems.

## Statement of Purpose

The purpose of this research was to examine cooperative learning as an instructional method to be used in an industrial technology classroom to increase academic achievement. The research had the following four components:

1. Identify the major cooperative learning methods being used.
2. Synthesize the research done on cooperative learning with an emphasis on mathematics instruction in secondary schools.
3. Conduct a mail survey to determine the perceived success of cooperative learning among professionals instructing the principles of technology course.
4. Develop conclusions and recommendations to specify the cooperative learning procedure which will result in significant achievement gains when working math lab problems in a principles of technology classroom.

## Statement of Problem

Working together in a dynamic group process has been shown to be highly effective in maximizing learning outcomes and helping students realize greater academic and social skills (Glasser, 1986). A great deal of research has been conducted on the relationship of cooperative, competitive, and individualistic efforts and instructional methods (Johnson, Johnson & Holubec, 1988). Johnson and his associates in 1981 (as cited by Wood, 1987) revealed that instruction focusing on cooperation and collaboration resulted in significant gains in achievement, self-esteem and social development. Many viable and successful forms and hundreds of thousands of enthusiastic adherents have realized extraordinary successes using cooperative learning (Slavin, 1989). Sharan and Pepitone, both in 1980 (as cited by Wood, 1987) explored the differential effects on students' attitudes, achievement and ethnic relations in cooperative learning. Without a doubt, cooperative learning has become one of the promising options for the future of education.

Although a great deal of research has been done which documents the positive effects of cooperative learning at the primary and secondary levels, very little research has been done to document the effects of cooperative learning in the industrial technology classroom. One purpose of this study was to review the literature and draw conclusions as to how cooperative learning can be used to enhance student motivation and achievement in a principles of technology course.

In the typical classroom of today, each student works alone. This approach is totally contrary to one of the basic human needs to belong to something or someone. The idea of having students function as a group to produce some result has been carefully studied and it works (Glasser, 1986). Students working together in groups such as band, chorus, school newspaper, yearbook, and athletics, have traditionally been successful. The tradition of using the group process in industrial technology (Maley, 1966) can perhaps be even further enhanced in the principles of technology course by incorporating cooperative structures which have been shown to be effective elsewhere in the curriculum. An important purpose of this study will be to provide a means for principles of technology instructors to develop an instructional method which will enhance the course.

## Research Questions

An extensive research of the literature on cooperative learning was conducted during the course of this study. This, coupled with a mail questionnaire, was analyzed to answer the following research questions:

1. What are the characteristics that make cooperative learning successful?
2. How can cooperative learning techniques be adapted to principles of technology units of instruction to enhance learning achievement?
3. Will principles of technology students achieve greater academic results when exposed to cooperative learning methods as opposed to more traditional frontal teaching techniques?
4. Is motivation positively enhanced through the use of cooperative learning?

## Need for the Research

Recent educational thought and research have shown the benefits of cooperation to learning and social relationships between sexes and races worldwide. As social changes have occurred, the traditional academic curriculum has changed to develop students' interpersonal skills. Teachers have become convinced, and theory and research from the social sciences have strongly shown, that cooperative activities in the classroom enhance the learning of the traditional academic curriculum (Schmuck, 1985).

The roots of cooperative learning in American schools are substantially founded in the works of John Dewey. Dewey was an educational reformer who believed in the social aspects of learning and emphasized the role of the school in educating students using the cooperative method. The philosophical insights of Dewey have also historically been used to support the role of industrial technology in the public school. His views reflect the contemporary aims of industrial technology to generate intellectual thought and encourage manual, technical and social skills (Downes, 1978). The Deweyan influence on educational reform has been significant in the years since his research in the early 20th century. The key to unlocking Dewey's philosophy about cooperation and learning has come to light in later years through a substantial body of scientific research on the functions and processes of groups. Lewin, Lippitt and Deutsch in the 1940s spearheaded the application of Dewey's philosophy as it applies to contemporary cooperative learning theory (Schmuck, 1985). From the 1970s to the present time, Johnson and Johnson, Slavin, Kagan, Hertz-Lazarowitz and Glasser, to name a few, have done extensive research on cooperative learning models. Kohn (1986) stated that "cooperation is a shrewd and highly successful strategy--a pragmatic choice that gets things done at work and at school even more effectively than competition does" (p. 7). Contemporary industrial technology programs, exemplified by the Maryland Plan (Householder, 1979) have given significant credence to cooperative methods in industrial technology. Maley (1966) stressed the importance of group cooperation in the American Industries Project. The successes of these programs initialized a number of similar programs involving the group process.

Although cooperative learning has received superior accolades from the educational research community, most of the research done has been in elementary classrooms. Secondary schools can also benefit from the positive effects so apparent in the research. Because they differ substantially from elementary schools in organizational structure, teaching approaches, and because the motivation and behavior of adolescents may differ significantly from younger children, it is important to take a special look at cooperative learning at the secondary level (Newmann & Thompson, 1987). The relationship between cooperative learning theory and its application in the industrial technology classroom also needs to be considered.

## Limitations

To effectively research the problem of whether or not cooperative learning can be used effectively in the industrial technology classroom, a number of predetermined limitations were set. The factors surrounding this study within which the conclusion have been defined are: principles of technology courses in the state of Iowa were the intended subjects of this study.

1. Research literature available at the University of Iowa Main and Psychology Libraries and the University of Northern Iowa Library and Educational Resource Curriculum Lab have been used as the basis for this study.

2. Although cooperative learning is supported by a wealth of research, the conclusions have been limited to how it can be used to enhance motivation and achievement in a principles of technology course.

3. Conclusions have not been generalized beyond the use of the cooperative learning approach to solve principles of technology math lab problems.

## Operational Definitions

The following terms are defined to clarify their use in the context of this study. All terms are clearly identifiable by the research and although they apply to this study, common definitions can readily be discerned within the cooperative learning research literature.

Collaborative Skills: Using face-to-face interactions together in groups to reach a common goal (Johnson, Johnson, Holubec, & Roy, 1984).

Co-op Co-op: A cooperative learning method to allow students the option of exploring topics in great detail. Topic teams develop a coordinated presentation to the whole class (Kagan, 1985).

Cooperative Learning (CL): Students working together in small groups to accomplish shared goals (Johnson, et al., 1984). Cooperative learning will be used as a mode of instruction in a principles of technology classroom. [(CL) is not to be confused with cooperative education (CE) which is a separate secondary school program.]

Face-to-Face Interaction: A descriptive phrase used to explain peer instruction techniques (Johnson, et al., 1984).

Frontal Teaching: The traditional lecture method of instruction (Newmann & Thompson, 1987).

Individual Accountability: Assessment of student gains through tests, quizzes, or question and answer (Johnson, et al., 1988).

Individualistic Instruction: The traditional teaching method whereby the instructor presents information and students are expected to reach objectives independently through self-recitation and seat work (Johnson, et al., 1984).

Jigsaw: All students read a common narrative, but meet in expert groups for discussion and then instruct teammates (Slavin, 1988).

Negative Interdependence: A competitive situation where the structure sets the students against each other to achieve rewards (Johnson, et al., 1988).

Positive Interdependence: A group learning contingency whereby students must depend on one another to obtain team rewards (Johnson, et al., 1988).

Principles of Technology (PT): A high school course in applied science for vocational-technical students in the eleventh and twelfth grades. It is a 2-

year curriculum covering 14 units in applied physics.

Student Teams and Achievement Divisions (STAD): A cooperative learning approach consisting of heterogeneous teams with team rewards, individual accountability and equal opportunities for success as three central concepts (Slavin, 1988).

Structural: A categorization of cooperative learning which applies to a dozen or more strategies which transcend the STAD, TAI, TGT, and CIRC approaches and can be applied to all subject areas, and lesson plans, regardless of topic (Kagan, 1989).

Team Assisted Individualization (TAI): A cooperative learning approach whereby teammates check one another's work against an answer sheet and monitor progressions (Slavin, Madden, & Stevens, 1989).

Teams Games and Tournaments (TGT): A cooperative learning approach using the same format as STAD, but replaces the weekly quiz with a student tournament (Slavin, 1988).

## Related Research and Information

A wealth of research literature exists concerning cooperative learning and the propagation thereof. Most of the available literature has established two conditions that must be fulfilled if cooperative learning is to significantly enhance student achievement (Slavin, 1988). The cooperative group must first develop what most researchers call positive interdependence--a group goal whereby all students are responsible for the growth of the group and each member involved

(Kohn, 1987). The second condition which must be addressed by the cooperative process is individual accountability. The group must be working to achieve some goal and the success of the group must hinge on the individual learning of every group member (Johnson, Johnson, & Holubec, 1988). Although approaches may differ, most researchers agree to these two basic premises of cooperative learning.

Cooperative processes are also well documented in the educational field known as industrial technology. Colonel Francis Parker, superintendent of the public schools at Quincy, Massachusetts (1875-1880) was famous for his cooperative learning procedures in an exemplary manual training program (Barlow, 1967). John Dewey with his philosophy termed the "New Education" (Dewey, 1907) linked the virtues of both cooperative learning and industrial technology as we know them today.

Research on specific applications of cooperative learning to the classroom began in the 1970s. Student Teams and Achievement Divisions (STAD) is an approach consisting of heterogeneous teams with team rewards, individual accountability and equal opportunities for success as three central concepts (Slavin, 1988). Co-op developed from a need in a college psychology class to streamline the research process of exploring in depth topics. Topic teams are formed to develop a coordinated presentation to the whole class (Kagan, 1985). Teams games and tournaments (TGT) parallels the STAD approach but utilizes a variation for individual accountability (Slavin, 1988). Team assisted individualization (TAI) is a team approach whereby teammates check each other's work against an answer sheet and monitor progressions (Slavin, Madden, and Stevens, 1989). As mentioned in the introductory paragraph, most methods emphasize the two basic premises of positive interdependence and individual accountability when student achievement gains are the goal.

Much applied research has been devoted to the aims of cooperative methods in the classroom. Most of the research has been performed in elementary classrooms, with many subject areas represented. This research will examine in some detail two such studies. In the study entitled Mathematics Achievement In Cooperative Versus Individualistic Goal-Structured High School Classrooms (Sherman & Thomas, 1986), a quasi-experimental approach was used to test the effectiveness of cooperative learning. This research was selected because it closely parallels the problem of this study. The second study by Sharan, Ackerman, and Hertz-Lazarowitz (1979) hypothesized that pupils who engaged in small group learning would display superior performance on measures of higher level cognitive functioning than would pupils in classrooms where teachers use traditional presentation techniques. Researchers in both studies found that cooperative learning does positively impact student motivation and achievement. With comparable variables and a similar setting, similar results could be expected in PT.

## Research Design and Methodology

The goal of this study was to determine if motivation and achievement of students can be improved by cooperative learning techniques. A library search of the available literature followed by a survey questionnaire to be filled out by the principles of technology teachers in Iowa was the primary data collection method. Questionnaire design was assured to have face and content validity in a review by two University of Northern Iowa instructors. The responses were analyzed using descriptive statistics.

Based upon the literature, conclusions were developed which answered the research questions. A thorough investigation of the available literature was performed to uncover any relationships between cooperative learning and student achievement/motivation. Journals, monographs, and books covering the topics of cooperative learning, social and psychological principles of learning and industrial technology were reviewed. Sources for the study included:

A. Journals

Educational Leadership, Change, Action in Teacher Education, Phi Delta Kappan, Journal of Teacher Education, Psychology Today, Journal of Reading Behavior, The Education Digest, Educational Researcher, American Educational Research Journal, Contemporary Educational Psychology, The Journal of School Psychology, Review of Educational Research, Journal of Experimental Education, Journal of Educational Research, American Educational Research Journal

B. Books & Monographs

Circles of Learning, Student Team Learning: An Overview & Practical Guide, Dewey on Education: Selections, Methods, of Psychological

Research, Methods in Behavioral Research, John Dewey the Middle Works, The School & Society, Dewey On Education, Control Theory In The Classroom, Industrial Arts Education: Retrospect, Prospect, Cooperative Learning: Student Teams, Experience and Education, Learning to Cooperate, Cooperating to Learn, Group Processes in The Classroom, Children in Cooperation and Competition, History of Industrial Education in the United States, Learning Together & Alone, Life Needs and Education, No Contest, Effects of Cooperative Learning on Achievement in Secondary Schools: A Summary of Research

# CHAPTER 2

## RELATED RESEARCH

In the first century AD, Quintilian argued that students could benefit from teaching one another. Johann Amos Comenius (1592-1679) believed that students could be positively influenced by frontal teaching and group learning processes (Johnson, et al., 1988).

During the "age of enlightenment" in Europe in the late 1700s, Joseph Lancaster and Andrew Bell developed a Lancastrian School utilizing cooperative learning in England. This movement spread to America when a Lancastrian School was opened in New York City in 1806 (Johnson, et al., 1988).

The use of cooperative learning is not new to American education. Hundreds of research studies beginning at the turn of this century have generated a consensus that cooperative learning theory does have a great deal of merit. This substantial body of research has established that two conditions must be fulfilled if cooperative learning is to significantly enhance student achievement (Slavin, 1988). The cooperative group must first develop what most researchers call positive interdependence--a group goal whereby all students are responsible for the growth of the group and each member thereof (Kohn, 1987). The second condition which must be addressed by the cooperative process is individual accountability. The group must be working to achieve some goal and the success of the group must hinge on the individual learning of every group member (Johnson, et al., 1988). Most of the research dealing with the cooperative learning process has been structured to measure student outcomes when these two essential conditions are present.

## Early Research

Two of the pioneers in American education were advocates of both cooperative learning and the movement that led to the present day industrial technology curriculum. Colonel Francis Parker, superintendent of the public schools at Quincy, Massachusetts (1875-1880) averaged more than 30,000 visitors a year to experience his use of cooperative learning procedures (Barlow, 1967). In a general program, which included an exemplary manual training curriculum, the cooperative learning theory showed promise.

Another forefather of American industrial technology and cooperative learning was John Dewey. In 1899, he was a leading educational researcher at the University of Chicago who defined the social meaning of education in an industrial society. His series of lectures and ensuing monographs in "The School and Society" defined his vision for the schools of the early 20th century. His philosophy, termed the "New Education" (Dewey, 1907) supported both cooperative learning and industrial technology as we know them today.

Dewey believed that schools could not be effective without the element of common and productive activity. He saw no obvious social motive for the acquirement of mere learning and decried the failure of competition as a comparison of results in recitation. A Dewey idea that permeated the thinking at the time was the importance of manual training and the need for education to be reality based. His famous project method demonstrated the usefulness of teaching about occupations in a social context. At the University of Chicago Laboratory School, his progressive ideas about education were found to be experimentally supported (Dworkin, 1967).

In the late 1930s, the influence of competition in American schools emphasized individual achievement and downplayed student-to-student interaction. Rewards were based on competition for grades and teacher approval, resulting in discouragement rather than encouragement of one another's academic efforts (Slavin, 1988). This competitive structure has largely remained the principle mode of instruction, in American schools today.

Research studies in the late 1940s by Morton Deutsch (as cited in Johnson, et al., 1988) rekindled the discussion and present day interest in the movement. Deutsch identified a theory of how students can interact with each other as they learn (cited in Wood, 1987). He identified three goal structures which are universally addressed today by cooperative learning researchers: cooperative, competitive and individualistic.

## Approaches and Methods for Cooperative Learning

Further interest in collaborative learning in schools is supported philosophically by recognizing that the whole world works collaboratively as a universal principal. The Japanese quality circle approach is increasingly being used to supplement the individualistic approach in factories and businesses worldwide (Bruffee, 1987). Cooperative learning and industrial technology are grounded on similar philosophies, beginning with John Dewey and more recently with the Maryland Plan. "Doing things to produce results in a social and cooperative way. . ." (Dewey, 1907) is also a principle of the Maryland Plan) and most of the innovative curriculum of the 1960s and 70s in industrial technology. The Maryland plan was formulated by Donald Maley, a University of Maryland industrial arts curriculum developer (Householder, 1979). Portions of the Maryland Plan: collective group projects, research and experimentation, line production, problem solving, and technical development are incorporated in the present-day industrial technology curriculum.

Research on specific applications of cooperative learning to the classroom began in the 1970s. Researchers continue to study practical applications of cooperative learning and its methods (Sharan & Sharan, 1989). The CL methods most frequently studied and their results on learning can be categorized into several approaches which have been recognized by the literature as successful models.

Student Team Learning or Student Teams--Achievement Division (STAD)

All cooperative learning methods emphasize the idea that students are to work together to learn and they are responsible for one another's learning as well as their own. In addition, student team learning methods center on team goals and the success of all members of the group. Students are to learn something as a team, with team rewards, individual accountability and equal opportunities for success as three central concepts. Team rewards are allocated when the group reaches predetermined goals. All teams or none of the teams may achieve the designated criterion for each lesson (Slavin, 1988).

Individual accountability means that team success in tutoring one another is realized when each team member is able to pass a quiz or test. Each team member must take the assessment without the benefit of help from other team members.

Equal opportunities for success is an opportunity for low ability students to contribute to their team reward by improving their own past performance. This feature ensures that high, medium and low achievers are challenged to do their best and assist in the team effort (Slavin, 1988). STAD is most appropriate for teaching clear cut objective subjects where the facts are known, like much of the principles of technology curriculum. Student motivation is enhanced by the encouragement provided from fellow students helping each other to master skills presented.

Teams-Games-Tournament (TGT)

This approach, developed by Devries and Slavin (Wood, 1987), utilizes the same format as STAD, but replaces the weekly quiz with a student tournament. Students compete in three-person divisions with those of similar ability. Low, medium, and high achievers are equally challenged and are able to contribute toward the team's reward. Teammates are not allowed to contribute answers, thereby ensuring individual accountability (cited by Wood, 1987).

Team Assisted Individualization (TAI)

TAI parallels the approach found in STAD and TGT, but provides the structure to operate at an individual instructional pace. It has been developed for use primarily in mathematics classrooms in grades three to six, but has been used at all levels up to the community college (Slavin, 1988).

Students are pretested for levels of attainment and then placed in ability groups. Everyday, the groups are taught specific concept lessons to develop an understanding of the connections between mathematics and real life problems. Heterogeneous teams comprised of low, average, and high achievers then work on self-instruction curriculum materials. Teammates check each other's work against an answer sheet and monitor progress (Slavin, Madden, & Stevens, 1989).

TAI attempts to combine the concept of programmed instruction with cooperative learning. Teams are responsible for many of the management functions, thereby freeing the teacher to work with individuals (Slavin, et al., 1989).

Jigsaw

Jigsaw was designed by Elliot Aronson at the University of Texas and later the University of California. Students work in four to five member teams to individually read a common narrative. Each student becomes an expert on a singular topic, by meeting in expert groups for discussion. Students then teach teammates what they have learned and finally take individual quizzes. Team scores are averaged and high scoring teams and individuals are recognized (cited in Slavin, 1988).

The Structural Approach

The structural approach to cooperative learning is based on the creation, analysis, and systematic application of structures or content free ways of organizing social interaction within a classroom (Kagan, 1989). Whereas other cooperative approaches are based on activities which have specific content bound objectives, the structural approach features a dozen or more structures which can be used to deliver a range of academic content in any subject matter, at a wide range of levels and at various points in a lesson plan.

Current Research

In the study entitled Mathematics Achievement in Cooperative Versus Individualistic Goal-Structured High School Classrooms (Sherman & Thomas, 1986), a quasi-experimental approach was used to test the effectiveness of cooperative learning. The hypothesis stated that the cooperative group would gain significantly higher post test scores than the individualistic group. The mean post test score of the cooperative group was 35% above the score of the individualistic group, confirming the hypothesis that cooperative learning is effective.

TGT/STAD models were used for the cooperative treatment classroom. The instructor of the treatment group had attended a graduate level course where she was trained in STAD/TGT techniques. The individualistic group was also taught by another female in the structure she normally uses in the class. The study ran for 25 days in two separate Midwestern high schools with heterogenous freshman and sophomore low-achieving students. The objective in both classes was to meet the state's high school mathematics credit requirement. The STAD/TGT group utilized frontal teaching, but all drill exercises were done in class and were structured using peer tutoring. The individualistic situation made use of teacher lectures, individual drill and seat work and homework assignments. A 30-item pretest/post test was designed collaboratively by the two instructors and was administered to each of the two groups at the beginning and again at the end of the study (Sherman & Thomas, 1986).

Although the data does support the hypothesis and the literature as cited by Sherman and Thomas (Slavin, 1980, 1983), close scrutiny discloses some discrepancies, some of which were realized by the authors. Both groups used in the study were not selected randomly and had n's of 18 and 20. As it were, intact classes would actually yield an n of one apiece. To have verifiable data, a study should maintain a minimum of 30 samples to assume generalizability. The results of the study, however, do agree with 46 experimental studies conducted by Slavin (as cited by Sherman, et al., 1986), where small group cooperative structures were more consistently effective in improving achievement.

Other factors which may have affected the internal validity of the study were the teaching skill differences of the two instructors and an untreated control group design in a quasi experimental study. Both are factors which can never be fully controlled when working with human subjects and can only be generalized by replicating the study again and again with randomization each time.

Reliability of the pre- and post tests (one in the same) was assured by a Kuder-Richardson-20 reliability coefficient of .86. The mean scores of both groups were similar on the pretest, but the cooperative group obtained significantly higher achievement on the post test than did the individualistic group (Sherman, et al., 1986). The data strongly support Deutsch's theories (as cited by Sherman, et al., 1986) concerning the effectiveness and motivational qualities associated with cooperative methods of instruction. The implications are important for the research to be undertaken because of the similarities of the subjects and settings (high school students in a mathematics classroom) and the pedagogical strategies involved.

In one study by Sharan, Ackerman, and Hertz-Lazarowitz (1979) it was hypothesized that pupils who engaged in small group learning would display superior performance on measures of higher level cognitive functioning than would pupils in classrooms with traditional presentation. Academic achievement was compared via five control and five treatment classrooms for grades two through six in the same Israeli community.

This study had more control over the independent variables. The authors of the study trained the small group teachers for 1½ years and allowed them to practice the techniques for a full academic year prior to the onset of the experiment. Teachers from the control and experimental classrooms were matched on several variables: age, education, and teaching experience. All teachers selected for the project were rated as excellent by their principal.

The topics for instruction were chosen collaboratively by teacher pairs for each grade level. After the topics had been chosen, experimenters collected materials from a variety of sources and the learning materials presented to both groups were identical (Sharan, et al., 1979).

The learning process differed considerably in the two groups of classes. "Pupils in the small groups planned their lessons in terms of subtopics, the division of labor, the conduct of their own study of available resources and discussions" (Sharan, et al., 1979, p. 127). Teachers using the whole class approach lectured and asked questions and assigned identical homework to each student.

Trained observers conducted systematic observations on a regular, but unannounced basis. Thew's Classroom Social Organization Category System provided the categories and instructions for the observational procedures (Sharan, et al., 1979).

Achievement tests were prepared by teachers in accordance with procedures outlined by Lewy (as cited in Sharan, et al., 1979). After careful analysis, the formulated tests were given to five educators, including two university instructors, two instructors in teacher training and one teacher. Judges rated the tests and re-development ensued until they reached an 85% agreement on the content validity of questions and 85% agreement on proper classification. Scoring criteria were then developed based on a point scale depending on the complexity of the potential response. High level and low level questions could then be categorized along with a range of scores for each grade level.

Standard tests of reading level comprehension were administered to all pupils. Since reading ability has a profound effect on achievement in elementary schools it was important to control for the difference in reading level (Sharan, et al., 1979).

The findings supported the hypothesis that small group learning is instrumental in promoting superior achievement in higher order thinking skills. "Coupled with the marked advantages of small group study in promoting children's development on a host of social psychological variables, it appears that small group learning is an effective alternative to traditional presentation and recitation teaching and learning" (Sharan, et al., 1979, p. 128). This quasi-experimental study was conducted 10 years ago when much less verifiable data was known about the value of cooperative learning and it had not been as fully established. Variables were tightly controlled and left very little room for error.

Due to the nature of the study, however, results are not conclusive proof of the effectiveness of cooperative learning, but the tight control gives a good prognosis of internal validity and external generalizability. This study involved only 9-12 hours of instruction and intact classes were used. The findings of this study have important implications for the study to be attempted. The cooperative group's attitude toward an achievement test revealed an increased involvement, demonstration of pleasure and concern for the aesthetic side of the work (Sharan, et al., 1979). The researchers have found that cooperative learning does impact student motivation and they addressed the same variables as the study to be attempted. With comparable variables and a similar setting, similar results are to be expected (Sharan, et al., 1979, p. 128).

# CHAPTER 3

# RESEARCH METHODOLOGY

Integrating cooperative learning into high school principles of technology courses can be challenging and rewarding for industrial technology teachers. Any new teaching methodology should be founded in a research literature that supports it's use through empirical means. An attempt has been made in this research project to identify and validate cooperative learning strategies and their use in principles of technology courses.

## Integration of Research

Standard research methodologies have been used in this study. Journals, periodicals, library books, monographs and other literature were consulted to determine the theoretical significance of the problem statement. Through library research, results have been formulated about the characteristics that make cooperative learning successful and the cooperative methods most likely to enhance learning and achievement in a principles of technology course. A questionnaire survey was then developed to assess the extent to which principles of technology instructors have used cooperative learning. Another goal of the survey was to appraise the degree to which instructors do believe they have achieved success in promoting increased student academic benefits and higher levels of motivation.

## Questionnaire Survey Construction

To inquire about how cooperative learning is being utilized by principles of technology instructors throughout the state of Iowa, a questionnaire was developed. The composition of the questionnaire was based on the research questions of this study. Individual questions were developed in conjunction with teacher educators and numerous graduate students in technology education. A pilot of the instrument was juried by Dr. M. Roger Betts and Mr. William K. James of the University of Northern Iowa industrial technology department. Both of these gentlemen have a great deal of experience in teaching and were very insightful in providing suggestions to facilitate the face and construct validity of this instrument (Appendix A).

The teacher population was selected based on the principles of technology instructors currently teaching in Iowa. Mr. Harold Berryhill, a consultant with the Bureau of Career Education, Department of Education in Des Moines, Iowa, was contacted for a listing of all principles of technology instructors throughout the state. Unfortunately, Mr. Berryhill was not able to supply a listing of teachers, however a listing of the 51 schools in Iowa was included. With help from Mr. Curtis Corwin, and the University of Northern Iowa, Division of Continuing Education and Special Programs department personnel principles of technology teachers in Iowa were identified and approximately one half of the addresses were obtained. An afternoon was spent at the University of Northern Iowa main library to locate the remainder of the addresses in the reference collection of Iowa telephone directories. The addresses of 47 of the 51 instructors were identified and a total of 48 return envelopes and cover letters were prepared (Appendix B).

Prior to the final printing of the survey, Mr. Mike Courbat a doctoral student at the University of Northern Iowa was asked to read through the materials to verify the instrument for clarity and understanding. Mr. Courbat suggested several changes which were incorporated into the cover letter and survey.

## Data Collection

Forty-eight surveys were sent to the 47 instructors located throughout the state of Iowa. Questionnaires numbered twenty-A and twenty-B were sent to the two individuals with the same name but different street addresses in the same city The surveys were mailed on June 29, 1990, with a requested return postmark date of July 6, 1990. At the end of a 12-day waiting period, a total of 22 questionnaires or 46% of the original 47 had been returned. An oversight by the researcher resulted in the omission of the requested return postmark date and may have caused a delay in the return of some of the questionnaires. All 22 (47%) of the questionnaires have been included as part of the data for this study. All instructors are currently or have recently taught principles of technology and provided suitable data for this study.

## Summary

The importance of the methodology for this study became apparent as the questionnaires were returning. A significant number of the instructors believed that some principles of technology students had difficulty in working the math lab problems. It became apparent that other PT instructors also have a need for an improved method of teaching the math labs. The results of the data analysis of the questionnaire and the literature research will be invaluable in answering questions that face teachers when instructing students in the mathematical concepts involved in the course.

# CHAPTER 4

# ANALYSIS OF DATA

The significance of this chapter is to analyze the data obtained from the questionnaires concerning the usefulness of cooperative learning in teaching math lab problems to principles of technology students. A total of 22 of the 47 (47%) of the questionnaires were returned. Six of the 22 instructors or 27% have taught principles of technology I for a 1- to 2-year period. Sixteen of the 22 instructors have taught principles of technology I for 3 or more years. Principles of technology II has been taught by 10 of the 22 or 45% for 1 to 2 years while 23% or 5 of the 22 have taught PT II 3 years or more. This yielded an experience base of at least 79 combined teaching years from which to extract the data.

## Need for Improved Methods of Teaching Principles of Technology Math Labs

Out of the 22 instructors who responded to the survey, 18 of 22 (82%) believe that some of the students in principles of technology experience a degree of difficulty with the mathematical concepts (Table 1). In addition, 16 of 22 (72.8%) believe that 11% through 80% of the students enrolled in principles of technology experience difficulty in understanding the mathematical concepts (Table 2). This result would seem to indicate that a majority of instructors do surmise that a need does exist for improving the methods of teaching mathematical concepts to principles of technology students.

Table 1

NUMBER OF STUDENTS HAVING DIFFICULTY UNDERSTANDING MATHEMATICAL CONCEPTS AS PERCEIVED BY PRINCIPLES OF TECHNOLOGY INSTRUCTORS

| Perceptions of Respondents | Number of Teachers | Percentage |
|---|---|---|
| Respondents believing mathematical concepts difficult for some students | 18 | 82 |
| Respondents believing mathematical concepts not difficult for 0% through 10% of the students | 3 | 14 |
| Respondents unsure whether mathematical concepts difficult for some students to learn | 1 | 4 |
| | 22 | 100% |

Table 2

DISTRIBUTION OF STUDENTS HAVING DIFFICULTY WITH MATHEMATICAL CONCEPTS

| Ordinal Categories | Number of Students | Percentage |
|---|---|---|
| 0-10% | 6 | 27.2 |
| 11-20% | 4 | 18.1 |
| 21-30% | 6 | 27.2 |
| 31-40% | 3 | 14.0 |
| 41-50% | 1 | 4.5 |
| 51-60% | 1 | 4.5 |
| 61-70% | 0 | 0 |
| 71-80% | 1 | 4.5 |
| | 22 | 100.0% |

## Frequency of Cooperative Learning Use in Principles of Technology Courses

Table 3, reveals that 18 of the 22 instructors indicated they have used cooperative methods in teaching principles of technology students. One instructor reported that he had used cooperative learning in the hands-on scientific labs. Cooperative learning may also work admirably in the instruction of any or all units of the principles of technology course but the intent of this study has been to document the effectiveness of CL. It is not known if any other instructors also had this misconception, but it is believed that it does not seriously impair the validity of the instrument since the hands-on labs also deal with mathematical concepts.

Additional comments by two of the other instructors suggested that students in their courses gained significantly through cooperative learning. The initial data suggested that instructors have a basic knowledge of cooperative learning. Table 4 connotes a belief by instructors who have not tried cooperative learning methods that they would be willing to try it. Overall data analysis indicates a belief by 21 of the 22 instructors or a 95% majority who agree strongly with the research literature that the virtues of cooperative learning do warrant its use.

## Observations of Achievement and Motivational Improvements When Using Cooperative Learning Methods in Principles of Technology Courses

The questions numbered 11, 12, and 13 in the questionnaire concerned the perceived benefits of CL by teachers of students with low and high mathematical

Table 3

NUMBER & PERCENTAGE OF RESPONDENTS INDICATING PAST USE OF COOPERATIVE LEARNING METHODS TO TEACH PRINCIPLES OF TECHNOLOGY

| Past Usage of Coop Methods | Number of Teachers | Percentage |
|---|---|---|
| Respondent has used cooperative learning methods to teach students in principles of technology | 18 | 82 |
| Respondent has not used cooperative learning methods to teach students in principles of technology | 7 | 18 |
| | 22 | 100% |

Table 4

STATISTICAL BREAKDOWN OF TEACHERS NEVER HAVING TRIED COOPERATIVE LEARNING TO TEACH PRINCIPLES OF TECHNOLOGY

| Willingness To Try Coop Methods | Number of Teachers | Percentage |
|---|---|---|
| Respondents not having used cooperative learning, but willing to try it | 3 | 75 |
| Respondents not having used cooperative learning and unwilling to try it | 0 | 0 |
| Respondents not having used cooperative learning and unsure that they will ever use it | 1 | 25 |
| | 4 | 100% |

ability (Appendix E). Out of the 22 respondents, 18 who had previously used cooperative methods were considered to be the parameter for this section of the study. All 18 of the instructors reported achievement gains at least "part of the time" when working cooperatively. They also believed that 66% of the higher ability students and 55% of the lower ability students had made academic progress "most of the time," with indications on a five-point scale of a five denoting "always" and a one denoting "never" (Figure 1). A majority of the instructors also observed an improvement in student motivation when using cooperative methods. All 18 instructors believed that improved motivation could be attributed to cooperative methods (Figure 2). These findings agree wholeheartedly with numerous educational researchers who have documented the effects of cooperative learning through cause and effect studies. Under tight experimental conditions, cooperative learning students have consistently scored higher on achievement tests than students who have been taught by other methods (Krathwohl & Yarger, 1985).

## Student Attitudes Toward Cooperative Groups

Any curricular innovation must be acceptable and perhaps even enjoyable for the students involved to become a success. Salend and Sonnenschein (1989) revealed that 83% or 19 of 23 students in a general science class preferred working cooperatively to working independently. The principles of technology instructors also observed a very high student acceptance of cooperative methods. All of the instructors who have tried cooperative learning methods reported high

**Figure 1**

**TEACHERS OBSERVING STUDENT ACHIEVEMENT GAINS WHEN USING COOPERATIVE LEARNING METHODS**

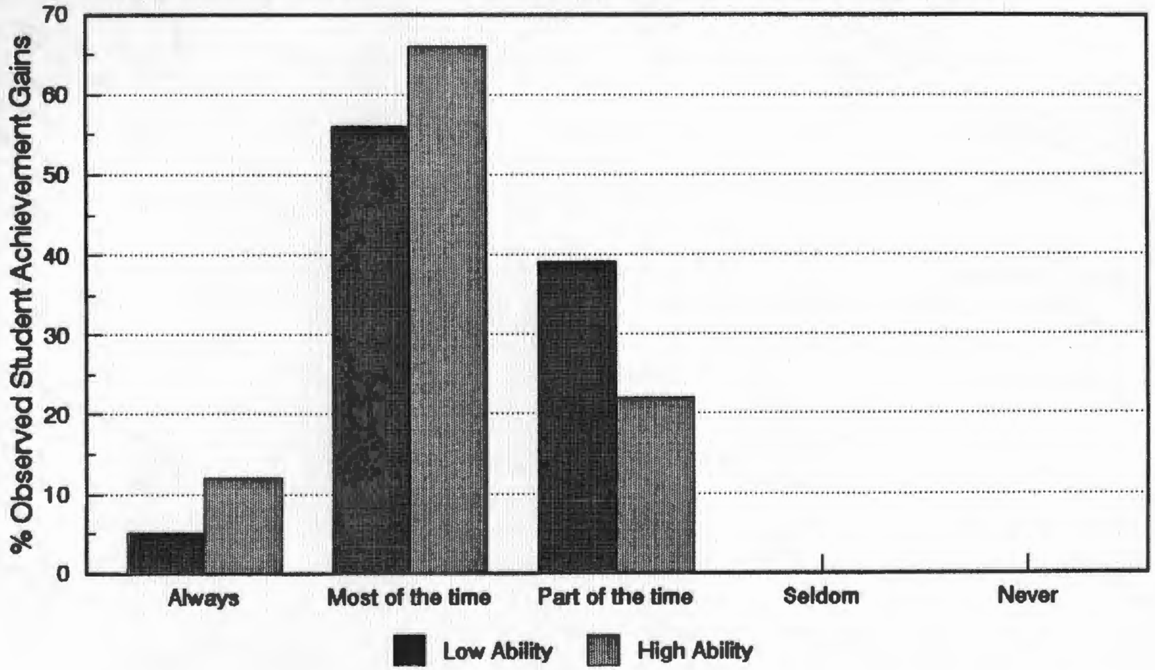
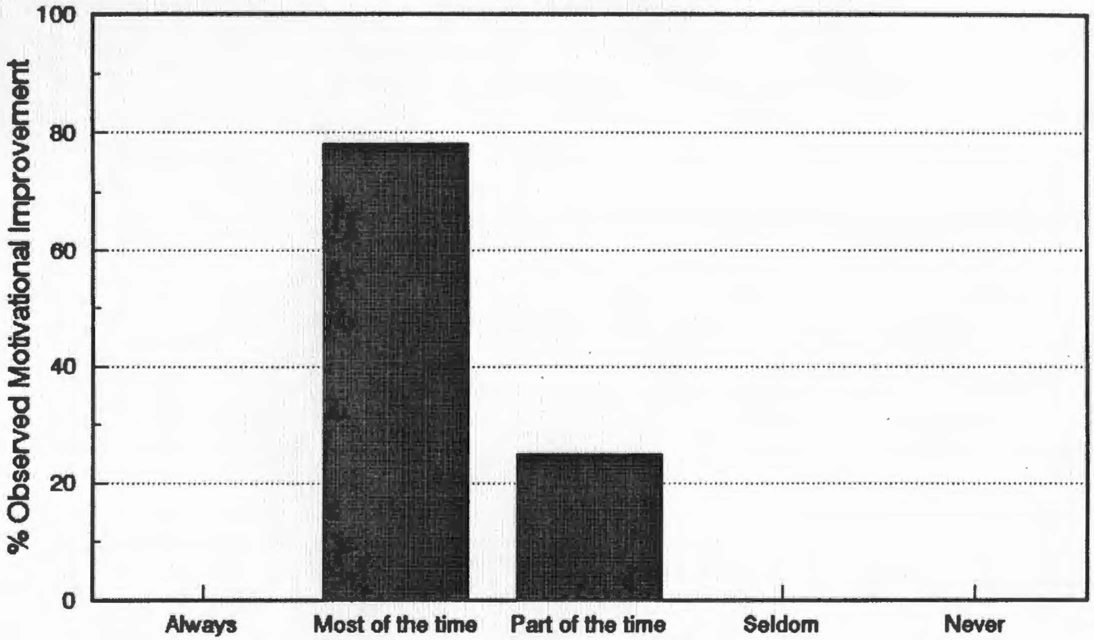


**Figure 2**
**TEACHERS OBSERVING STUDENT MOTIVATIONAL IMPROVEMENTS**



acceptance levels (Figure 3). Many of the researchers have reported a very good client satisfaction rate for cooperative programs (Slavin, Johnson & Johnson, Glasser, Kagan, Sharan & Hertz-Lazarowitz, and others). Principles of technology teachers can likewise benefit from a satisfied and motivated student clientele.

## Teacher Willingness to Use Cooperative Learning Theory

The teacher respondents involved in this study overwhelmingly supported the use of cooperative learning theory. Two categories--those who have not tried cooperative learning and those who have--were surveyed (Figure 4). The teachers who have used cooperative learning were most supportive with 100% or all 18 reporting positive support. Teachers not having used cooperative learning were also supportive with only one of the four (25%) stating they would "seldom" use it. In a study by Ferguson (1989), similar results were reported. Twenty-one of 23 student teachers who tried cooperative learning in a practicum espoused their future use of cooperative methods. Similar outcomes have been noted in other experiments when teachers have been given a choice of teaching methods.

**Figure 3**
**TEACHER OBSERVATIONS OF STUDENT ACCEPTANCE**

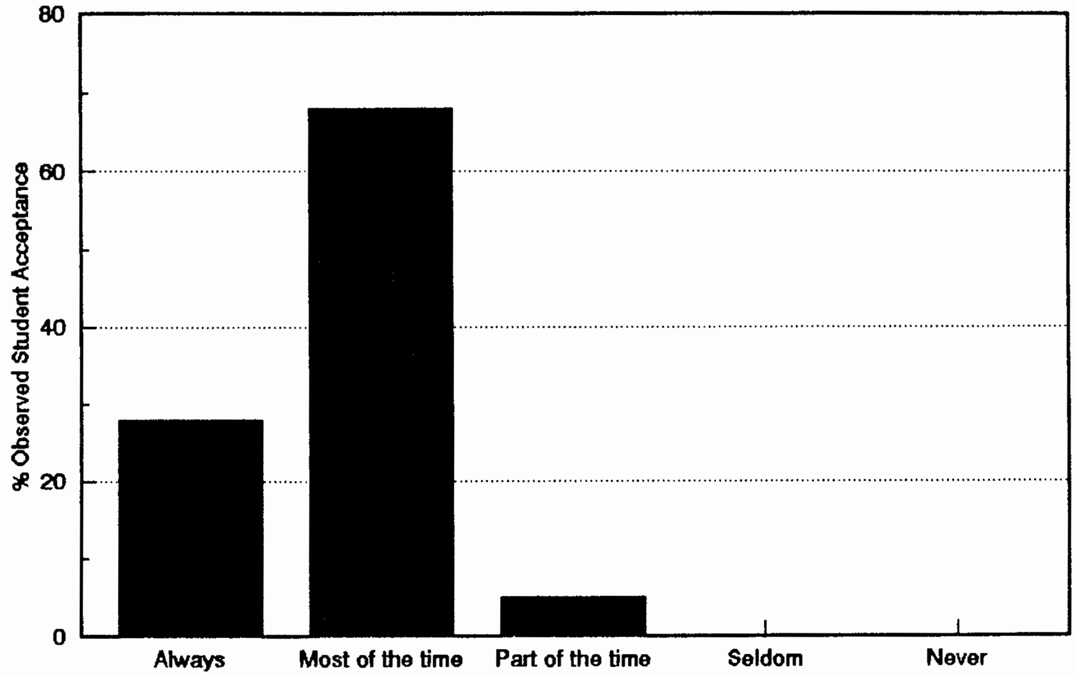
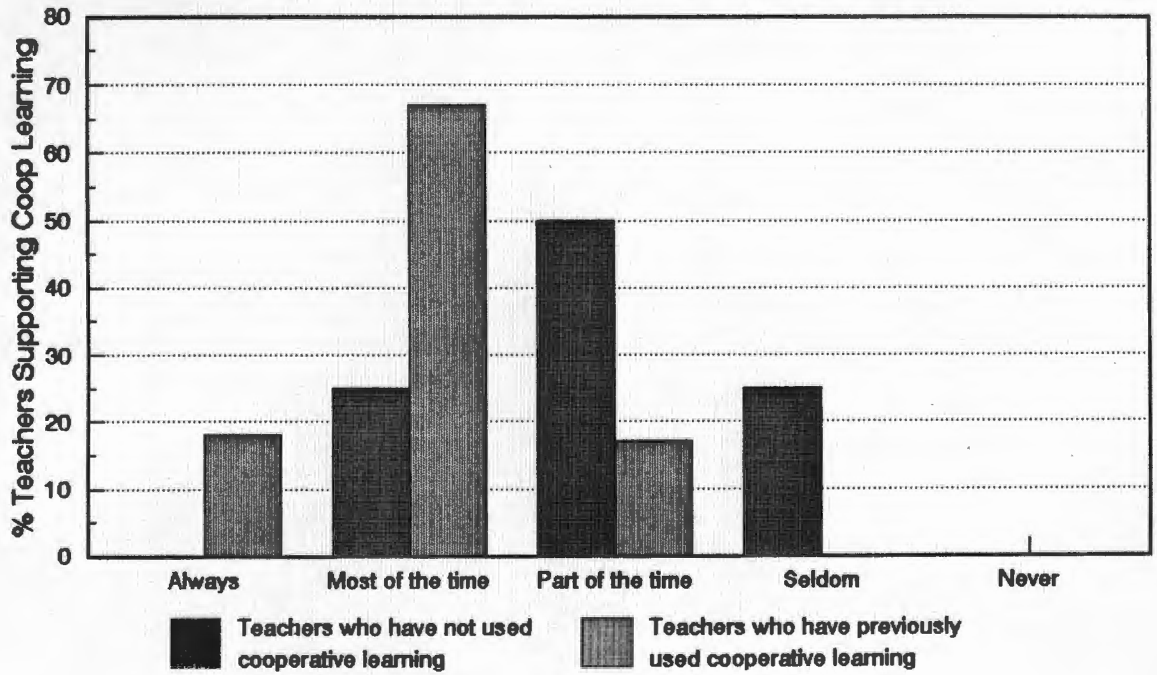


**Figure 4**

**PERCEPTIONS OF ALL TEACHERS SUPPORTING THE USE OF COOPERATIVE LEARNING**



# CHAPTER 5

# SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this research was to take a special look at cooperative learning as an instructional method to be used in teaching principles of technology math lab problems. The research was also focused on the major cooperative learning methods and especially those dealing with mathematics instruction. A survey was administered to Iowa PT teachers to ascertain the perceived effects of cooperative learning in principles of technology courses. A significant number of the respondents (82%) in the survey portion of this study do believe that the mathematical concepts in principles of technology are difficult for some of the students. The academic ability of the students involved in principles of technology is a good predictor of success. Lower ability students do need extra help and will not achieve success if their need is not addressed. Although cooperative learning theory may help all students, it may be crucial for the lower ability students to understand the mathematical concepts. A method must be found to satisfy student needs. Many students are not working or comprehending in school, because they may not perceive that school will satisfy their needs. Cooperative learning theory is a way to meet the needs of students--particularly those who may be having difficulty understanding the mathematical concepts.

## Summary

This investigation of cooperative learning started with a synthesis of historical information and cooperative learning theory as it applies to industrial technology as a discipline and principles of technology as a specific area within industrial technology. Applied research has been done to document the effects of cooperative theory. A dozen or more case studies were reviewed in selecting the two which were believed to be the most applicable to this project. The first, an experimental study of mathematics achievement in midwestern high schools supported cooperative learning theory using the student teams and divisions (STAD) and teams games and tournaments (TGT) approaches. The second, also an experimental study was chosen because of the stringent control of all situational variables. Cooperative learning was again found to significantly impact achievement and motivation.

In concert with the research literature synthesis a questionnaire was developed and sent to 47 principles of technology teachers across Iowa. The researcher has sought to ascertain the effectiveness of cooperative learning in teaching principles of technology math labs and determine the extent to which cooperative learning has improved student achievement and motivation. Of the 22 returns (47% response rate), all provided useful data. The findings indicated that 18 instructors (82%) reported use of cooperative learning theory. All of the past users supported its future use and only one out of four non-users would "seldom" support future use of cooperative learning in the course. With a large consensus of respondents supporting the use of cooperative learning, it appears that principles of technology teachers will use CL when teaching the math labs.

Eighteen of the 24 instructors (75%) held the belief that mathematical concepts were a problem for some of the students taking principles of technology courses. This would suggest that a majority of the instructors are experiencing difficulty in teaching the mathematical concepts to some of the principles of technology students. Two of the respondents reporting a low percentage of students experiencing difficulty indicated that all students at their school were required to successfully complete an algebra I course prior to being enrolled in principles of technology.

The instructors who had tried cooperative learning believed that students were easily convinced to work in cooperative groups. This would seem to indicate, concurrent with the research literature, that students do in fact prefer to collaborate with peers when given the opportunity.

Finally, all cooperative learning users reported that students of all ability levels can be positively impacted by cooperative learning. These findings further support the literature that cooperative learning can have a significant impact on motivation and achievement.

## Conclusions

The information gleaned from the research literature and colleagues teaching principles of technology has been enlightening. The goal of this study was primarily to incorporate a new teaching methodology into an already excellent course--Principles of Technology. It is believed that the industrial technology department is an ideal area in which to turn students on to mathematical and scientific concepts. Young minds need the chance to experience what they have learned and this is the very goal of industrial technology in the 1990s and beyond. However, the students who urgently need to understand these concepts have typically not fared well in traditional mathematics or science courses. Principles of technology and other courses have been created to provide an avenue to inspire the technicians of the future. Frustration leading to discouragement may course students to turn away from the course because they can not understand the mathematics. It is important to all of us that they are successful so they may gain the autonomy to seek a better future in a gratifying occupation. In lieu of these considerations, the following conclusions have been reached.

1. Any pedagogical theory must be based on a solid theoretical and empirical foundation.
2. Cooperative learning is a sound theory, but should not be construed to be a cure-all for everything wrong with education. It is simply a "tool" to be used as part of a larger system. The traditional approaches to instruction are not to be supplanted by cooperative learning but should supplement the current modes of instruction.
3. Any teacher undertaking the use of cooperative learning should fully understand and be comfortable with traditional frontal teaching methodologies. It is imperative that teachers be aware of the various cooperative learning theories and approaches to enable them to make the necessary choices for optimal conditions in the classroom.
4. Regardless of what cooperative learning approach is used, the two

critical attributes must be underscored as the key to success--positive interdependence and individual accountability.

5. Cooperative learning in the real sense of the term must not be construed to be "allowing" students to work together in an unstructured environment. Student cooperative learning must be positive and structured for the benefits to be realized.

## Recommendations

While cooperative learning is not the answer to all of the problems in teaching mathematics to principles of technology students, it is believed to be a step in the right direction. Based upon the review of literature and findings of this study, it is recommended that:

1. A simple solution to the problem would be to require all students to have a sufficient background in mathematics before enrolling in principles of technology. This is not altogether a practical solution and perhaps not even a desirable one. Principles of technology is for the middle 50% of a student population (ability groups). Algebra I is recommended but should not be required. Some students may be intimidated by an Algebra course and may never be allowed to enroll in principles of technology because of this. Excluding the targeted group is not the answer, however seeking methods to assist the average and below-ability student is a very real solution.

2. Teachers must be given the latitude to make choices concerning teaching strategies. The recommendation however is to use the STAD or TGT approach in working mathematical problems. These methods have been shown to be effective in mathematics classrooms where straightforward solutions must be found. This is not meant to imply that other methods should not or could not be used.

3. To be the most effective, student groups of three to four, heterogeneously arranged by the instructor should be utilized. Students will not align themselves in the most advantageous groups, therefore the teacher must do this. The information provided by the respondents shows that this is not currently always happening. (Appendix C).

4. This research on cooperative learning should not be considered a "manual" for teachers to put to use in the classroom, but rather as a guide to be used for directed study and further research into cooperative learning theory.

5. Institutions training technology education instructors should include information relative to the teaching methods utilizing cooperative learning.

6. Peer coaching needs to be made available for teachers willing to pursue cooperative learning. Local school boards and administrators will need to provide the necessary support.

# APPENDIX A

# COOPERATIVE LEARNING & PRINCIPLES OF TECHNOLOGY QUESTIONNAIRE SURVEY

COOPERATIVE LEARNING & PRINCIPLES OF TECHNOLOGY
QUESTIONNAIRE SURVEY

As you are well aware, principles of technology (PT) is a rigorous course involving advanced mathematical and scientific concepts. Full comprehension of mathematical concepts is fundamental to student success in the course, but more importantly to their success in the real world. Some of the students we teach in PT seem to have a difficult time learning the mathematical concepts involved. My project is an attempt to use cooperative learning techniques to motivate students and increase their achievement.

Cooperative learning is not a new concept. John Dewey, in 1899 defined the social meaning of education in an industrial society. His philosophy implicated the virtues of both cooperative learning and industrial technology as we know them today. Cooperative learning has been shown by the current research to be a highly successful teaching approach. It involves the use of student groups working as a team to achieve group success and rewards. Students work together in heterogeneous groups on projects or assignments but can still be held accountable individually via the traditional test or quiz.

Please read the following items about the use of cooperative learning as a supplement to reinforce the mathematics concepts learned in the PT math labs. Answer as candidly as possible.

1. How many years have you been teaching a principles of technology I course? _____1-2 yr.
_____3 or more yr.
_____Have not taught it.

2. How many years have you been teaching a principles of technology II course? _____1-2 yr.
_____3 or more yr.
_____Have not taught it.

3. Do you believe that the mathematical concepts are difficult for some of the students to learn?
_____yes
_____no
_____unsure

4. What percentage of your students do you believe experience difficulty in understanding the mathematics involved in PT-I or PT-II?

| | | | |
|---|---|---|---|
| _____0-10% | _____31-40% | _____61-70% | _____91-100% |
| _____11-20% | _____41-50% | _____71-80% | |
| _____21-30% | _____51-60% | _____81-90% | |

5. Have you tried using cooperative learning or group activities similar to what has been defined in the opening paragraph to teach students in principles of technology?

_____yes
_____no

If "yes" please proceed to the directions for questions #9 through # 14. If "no" please continue with question #6, #7, & #8.

6. If you do not use cooperative learning techniques to teach mathematics, what method do you use after the lecture - discussion period to help students work math lab problems?
_____student participation (students work problems on chalkboard, etc.
_____peer helpers
_____individual seat work with instructor help only when asked for by student
_____individual seat work with continual instructor help
_____homework only

7. Do you believe that the cooperative learning approach would be an advantageous teaching strategy in terms of it's merit for helping students to learn? (See directions below for checking the appropriate number.)
_____5 _____4 _____3 _____2 _____1

8. Would you be willing to try cooperative learning methods if you have not already done so?

_____yes
_____no
_____unsure

Please proceed to question #15.

---

**Directions for questions #9 through #14: Check numbers 1 through 5 to indicate your responses.**

**5 for always**
**4 for most of the time**
**3 for part of the time**
**2 for seldom**
**1 for never**

---

9. Did you find that students were easily convinced to work cooperatively in groups?
_____5 _____4 _____3 _____2 _____1

10. For the cooperative process, did you select the student groups?
_____5 _____4 _____3 _____2 _____1

11. Do you believe the students with low mathematical skills improved their ability to work problems on the unit or subunit test or quiz following the cooperation activity?
____5 ____4 ____3 ____2 ____1

12. Do you believe the students with higher mathematical skills improved their ability to work problems on the unit or subunit test or quiz following the cooperation activity?
____5 ____4 ____3 ____2 ____1

13. Working in cooperative groups seems to motivate students to want to learn more.
____5 ____4 ____3 ____2 ____1

14. Do you believe that cooperative learning is a viable teaching methodology that can improve student achievement and motivation.
____5 ____4 ____3 ____2 ____1

15. In your school do you offer science or mathematics credit for principles of technology? ______yes ________no

If yes please proceed to # 16. If no please proceed to # 19 if you have any additional comments.

16. If yes (assuming a 1/2 credit for 1/2 year) does your school offer:
____1/2 credit of science or math and 1/2 credit of elective for each yr of PT
____1 credit of science for each yr of PT
____1 credit of math for each yr of PT
____1 elective credit for each yr of PT

17. Are you certified to teach in science or mathematics?
______yes ______no

18. If yes, do you believe that the principles of technology course merits a science or mathematics credit?

______yes ______no

19. Additional comments:

Please return this questionnaire in the enclosed, addressed and postage paid envelope with a postmark on or before July 6, 1990. Thank you for your contribution.

Mark E. Rhoads

# APPENDIX B

## LETTER TO PRINCIPLES OF TECHNOLOGY TEACHERS

University of Northern Iowa
Department of Industrial Technology

Industrial Technology Center
Cedar Falls, Iowa 50614
Phone (319) 273-2561

June 29, 1990

I am conducting a research project as part of a masters degree paper at the University of Northern Iowa this summer. This project is being done to learn more about how to motivate and help students achieve more in the course - principles of technology. More specifically, it involves the use of cooperative learning for teaching the math labs.

Would you please consider taking approximately ten minutes of your busy schedule to read the information and complete the enclosed survey. It is not important whether you presently use cooperative learning in your classroom, but your opinion is very important and will greatly benefit my study. I will need to complete my research data collection by July 9, and so I am asking you to return this survey with a postmark on or before July 6. Thank you very much for your input.

Sincerely yours,

Mark E. Rhoads

Iowa City, Iowa 52240
Telephone #

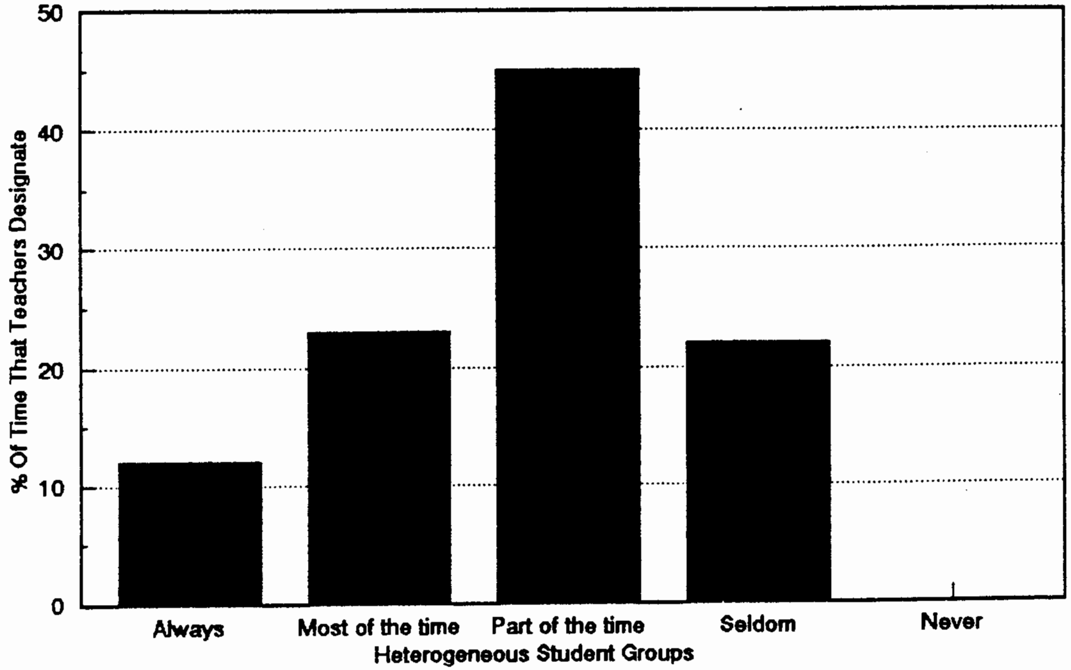
P.S. The questions, #15 through #18, about science and mathematics credit are for a proposal to help me to convince my principal at Muscatine High School that we should be giving an academic credit for this course. This has nothing to do with the survey about cooperative learning, but this information will also be helpful to me. Thank you.

Advisor Approval:____________________________

Dr. Ervin A. Dennis, Professor

APPENDIX C

## SELECTION OF STUDENT GROUPS FOR COOPERATIVE LEARNING



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# VITA

| Chronological Event and Place of Occurrence | Date |
| --- | --- |
| **Birth**<br>Iowa | |
| **Grade School Education**<br>Stanwood Consolidated Schools<br>Stanwood, Iowa | September 1955-May 1962 |
| **Secondary School Education**<br>Lincoln Community High School<br>Stanwood, Iowa | September 1962-May 1968 |
| **Undergraduate Education**<br>University of Northern Iowa<br>Cedar Falls, Iowa | September 1968-May 1972 |
| **Teaching Experience**<br>Industrial Arts Teacher<br>Clear Creek High School<br>Tiffin, Iowa | September 1972-May 1977 |
| Industrial Technology Teacher<br>Muscatine High School<br>Muscatine, Iowa | June 1987-present |
| **Graduate Education**<br>University of Northern Iowa<br>Cedar Falls, Iowa | June 1987-August 1990<br>(part time) |