EFFECTS OF PRETEST SENSITIZATION ASSOCIATED WITH COOPERATIVE LEARNING STRATEGIES ON THE ACHIEVEMENT LEVEL OF ADULT MATHEMATICS STUDENTS

by

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This dissertation is lovingly dedicated

to memories of:

James Gunasekera, my father

1901 - 1960

Seela Gunasekera, my mother

1907 - 1995

and to all my teachers.

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CHAPTER 1

Introduction to the Study

At the end of the twentieth century, people working in or concerned with education are confronted with profound uncertainties. In an era that is being called "postmodern," goals, contents, methods, outcomes in education are becoming increasingly diverse. Lyotard (1984) stated that "the time of the Great Discourses and ideologies is over," and that statement has found many echoes. Professionals of education - educators, policy makers and scientists - are being told to go and listen carefully to what the experts have to say (Bauman, 1992).

Careful listening has brought to the finding that the experts have very diverse opinions about education: some refer to education as a means to instill values and beliefs (Noddings, 1992), some others see it as the developer of rational thinking and solid knowledge (Goodlad, 1994), whereas some others talk about education as the provider of professional skills, or, on the contrary, as the excavator of slumbering potentialities (Carpenter & Fennema, 1992). However, the most common denominator is that education means production of different cultural goods, which a student gets at home and especially at school, which allows the successful high achievers to cope with their personal and social problems. "Get yourself a good education" is a standard message to young and old in many places in the world.

Consider this standard belief in education by means of an analogy. It is taken from the world of wine and wine-making. Wine, too, is seen as an end-product, made at a winery, owing its quality to the technical interventions of its maker. After a millennium of practice, there is a science of wine-making, called "oenology" (from Greek "oinos = wine" and "logos = knowledge"). The media, especially wine magazines, says that good wine is the product of a good wine-maker, using modern techniques (Reader's Digest, 1992).

This message contains little truth, because it tells only the last part of a long story. Good wine is often made from good grapes. Grapes grow on vines planted in a vineyard, during a season, which starts with the burgeoning of fresh leaves in early spring, and ends with the ripening of the bunches in early fall. That process is highly dependent upon the sun and the soil, and on necessary continuous care. One can only say that "cultivating grapes" is a process of complex interaction between nature and man. To see man as "wine-maker" is an overstatement. It is undeniable that modern technology plays an increasingly important role during wine-making, yet there is a definite limit to technical intervention. It operates within a triangle: nature, technique, and care. Only the combination of these three can explain why each year, each winery, and even sometimes each bottle brings a different wine (Reader's Digest, 1992).

Ability to make has long been at the core of concepts and practices of education. And a reason for that is that humanity and society was seen by professionals as "makeable." For example, consider the evaluation of achievement level of students; here testing becomes an important factor in the process.

Assessment occurs at the intersection of the important knowledge taught with how it is taught, what is learned, and how it is learned. It is a dynamic process that continuously yields information about student progress toward the achievement of the desired knowledge. When the information gathered is consistent with learning goals and is used appropriately to inform teaching, it can direct future learning, and also document it. The process of gathering evidence to make inferences about student learning, provides to students and all of those concerned with their learning, a sample of what is valued. It also provides how students are progressing toward specific goals based on that sampling.

Pretests are also administered before instruction, and results are used to establish a baseline. It could also be used to help decide which instructional materials are options. The teacher can use this information to plan review for any skills previously mastered and to develop lessons emphasizing skills that remain to be learned. Pretest data can also be used to group students who already have mastered most of the enabling skills and students who have not.

However, pretests can "inform" students about what is to come and affect their later scores, by that decreasing the internal validity of a study. Similarly, the presence of a pretest can change the nature of the treatment, so that the treatment applied to another setting is less or more effective without the presence of the pretest. To make things equivalent and maximize generalizability to other settings, the pretest would have to be part of the treatment, which, by definition, would change the nature of the treatment and the experiment's purpose (Salkind, 1991).

Context of the Study

The purpose of the study was to find out whether there was a significant pretest effect in the achievement level of adult students who were subjected to cooperative learning strategies as opposed to traditional teacher-centered instruction. Whereas pretest effects are well known and studied in psychology interventions for constructs such as personality, cognitive outcomes, and attitude outcomes, it is not known if pretest effects are prevalent in educational studies.

Hypotheses

This research attempted to answer the following hypotheses:

I. H_0: There is no significant pretest sensitization prevalent in educational studies.

H_1: There is significant pretest sensitization prevalent in educational studies.

II. H_0: There is no significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

H_1: There is a significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

The Significance of the Study

Pretesting is more likely to be a threat when the time between pretesting and posttesting is short. Pretest sensitization is also more likely to occur in some studies than in others. For example, taking a pretest on calculus is less likely to improve performance on a similar posttest, when the tests measure information that can be recalled. Because analysis of several research reports has shown that pretesting can be a problem in any study, the decision to use a pretest should not be made lightly (Willson & Putnam, 1982). If a pretest is used when dealing with educational variables, it is not clear whether a design should be selected which controls for pretesting. Therefore, if confounding due to the pretest can be ignored safely, then school districts can use them with cooperative learning strategies with greater confidence.

Assumptions Made in the Study

In one design frequently used to study the influence of the intervention, the behavior of interest is measured before ("pre") and after ("post") the intervention; the amount of change in the dependent variable is the focus of interest. This type of design is called the pretest-posttest design. Such questions are often studied by examining the amount of change in the dependent variable in the group exposed to the intervention. Though the pretest-posttest design is common, many problems are associated with it; these have been discussed by Campbell and his colleagues (Campbell & Stanley, 1963; Cook & Campbell, 1979), and it will be summarized here.

Single-Group Design Consider the assumptions associated with the pretest-posttest designs. The simplest kind of example is a study in which a single group is measured before and after all members of the group receive some treatment or intervention. But, even if the after measures are different, can the change be attributed to the intervention? The potential problems are discussed in Campbell and Stanley (1963) and Cook and Campbell (1979) and are briefly presented here:

1. *History.* Given that there is an interval of time between the two measurements (the pretest and the posttest), other events taking place in the time between the two measurements may be affecting the dependent variable, other than the special treatment (or the intervention).

2. *Maturation.* Many characteristics of subjects change over time because of internal events associated with aging. Thus, the maturation of people could

produce a change in posttest.

3. *Statistical regression toward the mean.* If there are two measurements on the same variable, low scores will show an increase in a score and high scores will show a decrease on a second administration due to some random fluctuations in most measures in the behavioral sciences. These statistical movements may distort the actual amount of change that takes place, particularly if the group studied happens to score quite low on the pretest, since the posttest will probably show some increase no matter whether there is an intervention.

4. *Testing.* Exposure to the dependent variable measure on the pretest may cause subjects to rethink and reassess their situation, and their change in thinking might in turn produce a change in posttest independent of the intervention. Thus, it may be that it is not the intervention per se that yields the change, but rather the act of testing, which can cause those serving in the study to perceive their environment differently on the second test, and, most likely, in a more favorable light.

5. *Instruments.* When the scoring of an instrument itself is affected, any change in the scores might be due to the scoring procedure rather than the manipulation of the independent variable.

Two-Group Design The above are some threats to conclusions drawn by researchers when a pretest-posttest design is used in a nonexperimental study. A possible remedy is to use a two-group design in which one group receives the intervention and the second group, the control group, does not. When a two-group study is conducted as an experiment, subjects are randomly selected and then randomly assigned to the two groups. In a nonexperimental design, however, random selection and random assignment is usually not possible; instead, each condition is likely to be represented by an already existing or intact group. In such a situation where subjects are not randomly assigned to one group or the other, the following potential problems exist with the design:

5. *Selection bias*. Because the subjects are not randomly assigned to the two groups, they will probably not be equivalent at the outset. Thus, differences observed between the control group and the experimental group may be due to initial differences in subjects rather than to the intervention.

6. *Selection-maturation interaction*. The subjects in the two groups may have different maturation levels. Thus, it may be that the existing differences between the groups explain different amounts of change in the dependent variable.

7. *Selection-history interaction*. Perhaps the different subjects are exposed to different events because they may be in different locations.

These are not the only factors that can limit the ability to interpret data obtained with the pretest-posttest design; others are discussed in the Campbell references cited above. But, the important point is that the design of the study decides the degree to which cause and effect can be addressed.

Limitations of the Study

Suppose the pretest-posttest design with a treatment group and a control group is used and potential limitations on interpretation such as history, maturation, and the other factors cited above are ruled out. The analysis can be refined by assessing the subjects and environments on many different kinds of variables (and finding the contributions of these variables to explained variance on the dependent variable), or the situation can be closely controlled to limit external influences. In reality, of course, the problem cannot be eliminated, but rather, the researcher can only be aware of them and consider when the results are interpreted.

Change or Difference Scores. One method of analysis makes use of change or difference scores for subjects who are exposed to the pretest and the posttest. That is, the mean of the difference between the pretest and the posttest scores of the treatment group is compared with the mean of the difference between the pretest and the posttest for the control group and tests whether the differences are significantly different. In essence, the measure that would be the unit of analysis is the change or difference score. But, the use of change or difference scores is not a good strategy for the following reasons:

1. Typically, there is a correlation between the difference score itself and the pretest and the posttest from which the difference score is obtained. Those who have low pretest scores will show greater difference scores (i.e., gains) than those initially high on the pretest; also, those with high posttest scores will show greater difference scores than those with low posttest scores. In essence, the difference score is dependent on or correlated with the pretest and the posttest. Thus, it may be that the difference score does not reflect the influence of the intervention, but instead is confounded by the pretest (or the posttest). Even if the control group has the same average pretest score as the treatment group, there is still a problem because of the existence of a correlation between the pretest score and the difference score. This correlation suggests that the influence of the pretest have not been removed from the posttest. Because of these difficulties, any comparison of difference scores between the two groups is spurious and artificial.

2. In almost all measurement situations, the concern is with the reliability of

measurement or test instrument or variables studied. Briefly, reliability is concerned with the consistency with which the variable of interest can be assessed; reliability estimates show the stability, internal consistency, and equivalence of the items or parts composing the measurement device (Ghiselli, 1981). If difference scores are used as the primary dependent variable, then it is using values formed by two components, a pretest and a posttest, each of which has its own degree of unreliability. Because few measures used in the behavioral sciences are completely reliable, use of the difference score compounds the unreliability of the two measures. The result is that the difference score is less reliable than either of its components. The problem is serious because any decrease in the reliability of a response measure will reduce the chances of finding a significant relationship with an independent variable.

Both of the above problems exist because a difference score is derived from the premeasures and the postmeasures. To repeat, the difference score usually is correlated with the pretest and posttest and is less reliable than the original measure. The analytical strategy used in this study to find the effect of an intervention without using difference scores is a simple 2 x 2 analyses of variance design along with analyses of covariance, having pretest score as the covariate.

Definition of Generic Concepts

Achievement — Accomplishment or attainment of educational goals.

Adult — Individuals who have reached a certain biological and psychological maturity (based on experience). It is most important to recognize that this definition of adult is not only individual, but also refers to collectivities such as communities, institutions, societies, and cultures who also experience and learn. It is claimed that educating an individual for change without the collectivities for this change is usually counterproductive (Wildemeersch & Jansen, 1992).

<u>Assessment</u> The process of gathering evidence about a student's knowledge of, ability to use, and disposition (toward mathematics) and of making inferences from that evidence for a variety of purposes.

<u>Cooperative learning</u> This is also called "small-group learning," "small-group teaching," or "group work." No distinction in meaning is intended.

<u>Education</u> Capacity to integrate, apply and deal with the impact of new knowledge and information. Thus, training is also a part of education.

<u>Equal</u> Having the same quantity, measure, value, privileges, status or rights.

<u>Equality</u> A state of uniformity in quantity, measure, value, privileges, status, or rights.

<u>Equitable assessment</u> The degrees to which the process of gathering evidence has provided opportunities equally appropriate for each student to display the valued thinking process.

<u>Equity</u> The states of quality of being fair, just, equally appropriate for all students.

<u>Evaluation</u> The process of deciding the worth of, or assigning a value to, something based on careful examination and judgment.

<u>Grade Equivalents</u> The scale for grade equivalents ranges from .0 through 12.9 representing the thirteen years of school (K through 12) and the ten months in the traditional school year. September is taken as the beginning of the school year (.0). For TABE 6, a grade eqivalent represents the grade and month in school of students in the CAT E and F norm group whose test performance is theoretically equivalent to the test performance of a given TABE examinee. Caution should be exercised in interpreting grade equivalents. If an examinee obtains a grade equivalent of 4.8 on a mathematics test, it does not mean that the examinee has mastered all the mathematics that is taught in the first eight months of grade 4. It means that the examinees performance on this test is theroretically equivalent to the typical performance of students in the CAT E and F norm group who had completed eight months of Grade 4.

<u>Measure</u> To suggest how much of the some specified, quantifiable unit is present; to assign numbers to variations in a quantifiable attribute or trait.

<u>Reliability</u> The degree to which assessment evidence supports a clear, complete, and accurate understanding of the quality of an individual student's performance across time, tasks, and scorers (i.e., credibility and representativeness of the evidence).

<u>Test</u> "A measuring instrument for assessing and documenting student learning. The traditional test is a single-occasion, one-dimensional,

timed exercise" (Hart, 1994, p. 114). "A formal, systematic procedure for obtaining a sample of students' behavior; the results of a test are used to make generalizations about how students would have acted on similar but untested behavior" (Airasian 1991, p. 440).

Traditional Instruction Instruction that incorporates the individualistic and competitive learning delivery strategies (Johnson & Johnson, 1994)

Validity The degree to which an assessment provides information that is relevant and adequate for the intended purpose. The reasonableness, quality, and efficacy of an assessment for particular educational purposes, decisions, and consequences are important issues of validity.

CHAPTER II

Review of Related Literature

The context of this study on pretest sensitization is adult education. The treatment strategies used in this study are adults achieving math skills using cooperative learning methods or traditional instructions. Some further discussions of these ideas are developed in this chapter.

The Effect of Pretesting on Posttest Performance

What effect does doing a test before instructions have on subsequent performance after instruction? Previous research has indicated that giving a list of questions before instruction, or before reading a passage, may sometimes enhance learning, e.g. Distad (1927), Berlyne (1954, 1956), Samuel (1969), Welch and Walberg (1970). Some investigators, both in industrial and educational contexts, have extended this type of finding by showing that not only does a pretest sometimes increase scores obtained on the same or similar questions asked in the posttest, but scores on posttest questions not given in the pretest are also increased, e.g. Washburne (1929), Holmes (1931), Kellogg and Payne (1939), McKeachie & Hiler (1954), Lumsdaine (1963), Warr et. al. (1970).

At the present time, sharp differences of opinion exist concerning the possible and probable consequences of giving students a test before the commencement of instruction. Researchers are unclear about the effects of such pretests on subsequent learning (if any), and they are also unclear about the effects of such tests on further tests (of varying degrees of similarity and difference) given after instructional sessions. There is evidence that pretests can have orienting and motivational and (hence) teaching functions, in addition to the sought for testing function. There is also evidence that these additional functions can be either general or specific.

<u>What Causes Pretest Effects?</u>

There appear to have been three kinds of results obtained in studies on the effects of pretesting:

(i) pretest effects have not been discernible;

(ii) pretest effects have been specific: i.e., subjects have scored highest on posttest questions that have previously appeared in the pretest but no higher than control subjects on other questions; and

(iii) in some studies pretest effects have, in addition, generalized, i.e., subjects (usually) have scored highest on posttest items that have appeared in the pretest, but have also scored higher on other questions than have control subjects who have not done a pretest.

How can these results be explained? In the more general literature (i.e., the papers not concerned with programmed or self-instruction) explanations of specific effects are usually given in terms of selective - or guided - attention. This explanation implies that the pretest directs the subject's attention to what he does not know, and that he pays particular attention to remedying these deficiencies during the instruction. This suggests that the students taking the pretest had somehow made a more effective use of the time available. This, however, might have been done in a variety of ways - for example, either by completely skipping that seemed in some way irrelevant, or by devoting less time on topics that had not appeared in the pretest or even the reverse of this - i.e. by giving a quick check to the pretest items to consolidate their meaning.

Explanations in the general literature of generalizing effects are usually given in the same terms as explanations of specific effects (e.g., selective / guided attention) but with "arousal" or "positive transfer" tagged on in addition: thus there are explanations such as (i) increased general arousal or attention (Sime and Boyce, 1969), (ii) increased curiosity (Berlyne, 1954, 1966), or (iii) increased awareness of what is expected helping the subjects to organize related material and thus making it easier to remember (Warr, et al. 1970). Such explanations seem to offer little more than a redescription of the results, and few investigators have sought to test predictions from them. In related studies, however, where questions have been asked during the instruction (rather than before it), some interesting experiments have been performed. Sime and Boyce (1969), for example, tried to test an "increased attention" versus a reinforcement explanation of the effects of questions in a grouped programmed learning context: in their first experiment predictions based on the attention model were borne out, but they were unable to replicate these findings in their second study (Boyce and Sime, 1969). In a study on prose learning, Natkin and Stahler (1969) found an interaction between level of arousal and testing time: they found concepts studied under conditions of high arousal (manipulated by asking questions) were poorly recalled on initial testing but better recalled on a retention test given one week later, and that the reverse of this was true for items presented under conditions of low arousal. Narkin and Stahler's results clearly suggest that long term retention should be considered in pretest studies; however few investigators have looked at this. The pretest effects had disappeared after a period of six weeks. According to another study, no pretest effects were found immediately or approximately nine days later (Gustafson and Toole, 1970). Peeck (1970), however, found that specific effects were more apparent after a period of seven days.

<u>What are the Important Variables in Pretest Studies?</u>

From examining the research literature, it appears that the important variables appear to be:

(i) the length and quality of the instruction,

(ii) the relevance of the pretest,

(iii) the age, ability and experience of the students involved.

(i) In most studies where pretest effects have been found, the instructional situation has been relatively short. Pretest effects were found with brief exposures to the treatment compared with long exposures. In other studies that have been much more lengthy (e.g., approximately seven months in Welch and Walberg, 1970, and involving a 23,000-word text in Gustafson and Toole, 1970) significant pretest effects were not found. In addition, it needs to be reiterated that the quality of the instruction is an important variable. In cases where the instruction is efficient - where all students learn to criterion, then, even if they exist, pretest effects cannot manifest themselves, but where the instruction is less efficient and/or where the students have to organize the materials for themselves, then pretest effects may be manifested.

(ii) It seems that the relevance of the pretest is an important issue. It seems unlikely that it is of much value to give a student a pretest on material about which he knows very little. A pretest requiring students, for example, to solve problems by using logarithms is unlikely to have much effect if the student has never seen a logarithm. It is perhaps for this reason that it is not surprising that, for example, Apter et al. (1971) failed to find pretest effects, for they pretested the knowledge of ten to twelve year old Welsh children on their knowledge of Afghanistan. Certain material is peculiarly suited for pretest studies. In such situations, the subjects think they already know (or ought to know) most of the material: here a pretest serves to alert them to their own (sometimes unexpected) deficiencies. It would also seem that the difficulty of the pretest, and its relevance, needs to be considered. In certain situations it would be useful to employ pretests that are moderately or fairly difficult (Hartley, 1972).

(iii) The age, the ability, and the experience of the subjects involved in these experiments is also important. Apter et al. (1971) suggested an age explanation to account for the failure to find pretest effects. However, Apter et al. failed to note that it could be the difficulty of the program rather than the ages of the subjects. Thus, age may be important, so too is the nature of the instruction.

Ability may also be important. Apter et al. failed to find pretest effects with either high or low ability children, but the differences were in the postulated direction for the high ability students and in the reverse direction for the low ability ones. Hartley (1972) failed to find the differences in the effects of various levels of difficulty of the pretest, but again greater differences in the postulated direction were found with high ability students. Such results would seem to suggest that ability be important. Research in a different context (intelligence testing) has also shown that pretest effects are more likely to manifest themselves with high ability children (Sullivan and Skanes, 1971). Related researches in the field of prose and verbal learning tend to suggest the reverse of the indications just implied (Ausubel and Robinson, 1969; Proger et al. 1970). They suggest that what they term "advance organizers" in instruction are more beneficial for low ability learners, but when the task is difficult, then such organizers may differentially benefit high ability subjects, or those with more background knowledge.

In terms of physical description, most pretests are simply sets of questions (often multiple choice) requiring short fill-in type answers. "Advance organizers," however, are more likely to be short prose passages (e.g., 500 words) which have "a high level of abstraction, generality, and inclusiveness" and which have either one or both of the following functions: "to provide relevant ideational scaffolding for the more differentiated learning task, or to increase the discriminability of the latter from related ideas in existing cognitive structure" (Ausubel, 1969). Experiments conducted by Ausubel and his colleagues have concerned themselves (i) with using advance organizers when students are required to learn new and unfamiliar materials (Ausubel, 1960; Ausubel and Fitzgerald, 1962) where the organizer can present appropriate (but higher level) concepts to which the new material can be related, and (ii) with using advance organizers to clarify relationships between the new material to be learned and the already existing (but perhaps confused or conflicting) ideas held by the learner about the topic in question (Ausubel, 1961).

In relation to pretesting, the main point is that with pretesting the main "anchoring ideas" may not be specifically identified, and certainly that their strength is not manipulated in any way. The aim of an advance organizer is to insure in advance the appropriate anchoring concepts will be available to the learner. It will be seen, therefore, that advance organizers involve much more deliberate cognitive restructuring than do pretests, which perhaps, as far as the students are concerned, are seen solely as designed to measure their existing preknowledge. The advantages of advance organizers compared with those that accrue from pretesting, intra-material organization and overviews are discussed by Ausubel and Robinson (1969). It seems that there is some overlap of ideas in the pretest and the advance organizer experiments, and that it would be worthwhile to design experiments both to clarify the distinctions and to evaluate the strengths and weaknesses of these approaches.

It seems to suggest that, where instruction is efficient - where all students learn to criterion - the effects of doing a pretest on posttest performance cannot manifest themselves. However, where the students involved may be different (e.g., older or of high-ability) and/or where the instruction is less efficient, it may be profitable to do a pretest.

The research findings suggest, in situations where pretest effects are produced, that not only doing a pretest alerts the learner's expectations about what is required, but also that this sometimes seems to assist in the organization of other related material so that it is more easily remembered. An implication of these studies for the educational psychologist is that it may be useful to test for pretest effects before deciding whether or not it is necessary for students to do a pretest in a subsequent, similar learning situation.

It may also be observed that the research shows it would be necessary to know more about the functions of tests and test questions, particularly in a systems approach to education. Effective teaching systems cannot be built if tests have unknown functions. Educational psychologists should pay close attention to related research in the area of "advance organizers" (Ausubel, 1969; Ausubel and Robinson, 1969), to the positioning of review items (Leith, 1967), to "text behaviors" (Rothkopf, 1970; Frase, 1970) and to the role of interim tests in self-instruction (Glaser and Resnick, 1972).

Meta-analysis of Pretest Sensitization Effects in Experimental Designs

The pretest is a common phenomenon in experimental and nonexperimental research. Campbell and Stanley (1963), Bracht and Glass (1968), Welch and Walberg

(1970), Jaeger (1975) have presented reviews of the effect of pretesting on posttest scores. Jaeger (1975) has advocated the use of pretests for many evaluation and research applications. The independent experimental contribution of pretests to dependent variables is unknown (Willson and Putnam, 1982). Welch and Walberg (1970) listed previous results in the usual review format of significance and nonsignificance and concluded that long term cognitive effects are small while there may be short term effects. They also suggested that these effects are greater for attitude tests than for cognitive tests.

As Glass (1976) pointed out, meta-analysis allows a systematic analysis of the pretest experimental effect. Instead of relying on dichotomous decisions about significance, the pretest effect is examined as a standardized difference between pretested and nonpretested groups. Willson and Putnam (1982) found that pretest sensitization effects provide two conclusions that have implications for educational, psychological, and sociological research. The first is that there is a general pretest effect that cannot be safely ignored. Nonrandomized studies with pretests must be viewed with additional suspicion, because the results indicate a systematic bias due to pretest in these studies. Selection of subjects is the likely internal validity threat. The second conclusion about pretest effects is that they do not appear to be consistent across psychological domains. The differences in effects under treatment conditions for cognitive and affective outcomes can be explained by reactive interference of treatments in cognitive situations. Treatments seem not to effect affective outcomes similarly.

The interesting reversal of effects under similar or dissimilar pretest to posttest conditions for cognitive and affective outcomes might be explained as follows. Cognitive gains will be largest with memory and practice effects when pretest and posttest are the same. Gains might still be made with dissimilar tests due to familiarity with testing procedures. For affective outcomes there may be halo effects in which everyone feels better on second attitude testing combined with regression when the pretest is dissimilar to the posttest. This presumes groups were extreme with respect to norms for pretest. In at least four studies involving affective outcomes, subjects were selected for some extreme condition.

A subset of the pretest sensitization literature has been concerned with the interaction of the pretest condition and treatment. Globally this hypothesized interaction does not appear to be large, if it exists at all, since the effect sizes for treated and untreated groups are so similar. The studies so far are not sufficiently exhaustive to provide definitive statements about conditions for variation of pretest sensitization, but promising areas of investigation are change in cognitive effects over grade and age level, transfer of pretest to different posttests, and change in effect over delay time between pretest and posttest from hours to months.

Pretest Sensitization, Meta-analysis and the Solomon Four Group Design

Is pretest sensitization germane to occur in education, psychology, and related research? As Sawilowsky, Kelly, Blair, & Markman (1994) pointed out, Bracht and Glass (1968) found that it may occur with self-report measures of personality, attitudes, and opinions. Although Willson and Putnam (1982) found that the interaction of a pretest with the treatment "does not appear to be large," in a meta-analytic study on the effects of pretests, they found the average effect size of pretest studies of personality to be 0.48, cognitive outcomes to be 0.43, and attitude outcomes to be 0.29. They concluded that, in educational, psychological, and sociological research, "there is a general pretest effect which cannot be safely ignored."

A solution to this issue was found in the Solomon four-group design, as shown below:

$$\begin{array}{llll} R & O_1 & X_1 & O_2 \\ R & O_3 & X_2 & O_4 \\ R & & X_1 & O_5 \\ R & & X_2 & O_6 \end{array}$$

This is a randomized experimental design consisting of two treatments versus two comparison groups. One set of two groups has a pretest and a posttest, and the other set of two groups has only a posttest. As pointed out by Sawilowsky, Kelly, Blair, & Markman (1994), many authors of education and psychology research textbooks praised this design (e.g. Ary, Jacobs, & Razavieh, 1990; Best, 1977; Borg & Gall, 1989; Fraenkel & Wallen, 1990; Gay, 1992; Helmstadter, 1970; Kerlinger, 1973; McMillan & Schumacher, 1989; Sax, 1979; Selltiz, Jahoda, Deutsch, & Cook, 1959; Sprinthall, Schmutte, & Sirois, 1991; Travers, 1978). Campbell and Stanley (1963) noted that this design "has higher prestige and represents the first explicit consideration of external validity factors" (p. 24).

Monte Carlo Results in Methodological Research

Monte Carlo studies provide information that can assist researchers in selecting a statistical test when underlying assumptions of the test are violated. Effective use of this literature is hampered by the lack of an overarching theory to guide the interpretation of Monte Carlo studies. The problem is exacerbated by the impressionistic nature of the studies, which can lead different readers to different conclusions. These shortcomings can be addressed using meta-analytic methods to integrate the results of Monte Carlo studies. Quantitative summaries of the effects of assumption violations on the Type I error rate and power of a test can assist researchers in selecting the best test for their data. Such summaries can also be used to evaluate the validity of previously published statistical results (Harwell, 1992).

The Education of Adults

The acceleration in the production, adaptation, dissemination and the impact of knowledge has created a massive need for education of adults. The changes occurring in various sectors of the contemporary world are creating a need for adults to develop the means for dealing with it. The education of adults has thus become a social necessity. A sector most affected by these profound changes is that of education itself: schooling, professional education, the education of adults, social and cultural work, special education, and continuing education. Furthermore, it is this sector that is called upon to develop and carry out new policies and practices required by society in dealing with these massive changes.

The increase of adult education programs around the world has been well documented (UNESCO, 1990). The training of managers, workers, technical personnel, the unemployed, social and cultural workers, and others now involve hundreds of millions of people and hundreds of thousands of programs. In the State of Michigan, for example funds related to training and retraining from the public sector alone is over a half billion dollars a year (UNESCO, 1990).

There are four problematic areas in the field of adult education:

- the relation of the education of adults to the just and wise government of society;

- the velocity of knowledge production and the capacity for its integration;
- the implications for the above in the transformation of industrial society to post industrial society;
- individual and collective human behavior in the tension between knowledge production and its integration.

There is a need for the education of adults to have good governance of society. It is this problem that Plato discussed in Book VII of the Republic that was the idea underlying his Academy, the institution out of which emerged the University. The second problem is tied to the changes resulting from the development of science, an inheritance that the ancient Athenians left for western civilization. These changes are the result of the accelerated velocity in the production of knowledge/information (with all its consequences of their transmission, application, and impacts). And, on the difficulties of the integration of this knowledge and its impacts by the individual, the institution, the community, the society and even the culture.

The third problem considers the socio-institutional, political, and the strategic situations that result from the contradiction between the methods and the institutions that inherited from the industrial epoch's effort at integration of knowledge and the conditions prevailing in the current postindustrial age. The knowledge/cultural change cycle in the industrial epoch being a generation (20-25 years) or so, while current knowledge/cultural change cycle is between five and seven years (Van Roosbroek, 1992). The industrial system thus used the education of the young both for their integration into the culture and having their education result in the integration of the new knowledge/culture into the society. The accelerated production of knowledge, resulting in the shortening of the knowledge/culture change cycle would mean the education of the young cannot provide for the second function and that a new system focused on the education of adults is now essential.

The fourth problem, which is critical from the perspective of this study, is concerned with the human behavior involved in the education of adults. What is the different learning behavior of adults, of institutions, communities, societies, and cultures? How to assess the level of achievement of adults? What are the environments and development stages related to these processes? Observing and analyzing this massive and wide range of behavior is not only essential for improving the current practice of the education of adults but also as an independent way of dealing with the other three problems. It is not difficult to see that these four problems are related. The importance for our society to be well governed has as a basic condition the education of its adults (Mezirow, 1991). The tensions that reunite and oppose current practice and institutional imperatives as strategies and politics organize, manage and repress certain practices; which in turn transform or replace these strategies and policies. The resolution of this tension thus becomes the second problem: the current contradiction between the velocity of production of knowledge and their required integration. The solutions to these four problems are each indispensable for the development of a solid theoretical base for the field and require extensive and sophisticated research, one by one as well as at the points of their interaction.

The treatment strategy the adults are subjected to in this study is cooperative learning and the content area is mathematics. Small-group cooperative learning provides an alternative to both traditional whole-class expository instruction and individual instruction systems. The procedures described are realistic, practical strategies for using small groups in mathematics teaching and learning. These methods can be applied with all age levels of students, all levels of the mathematics curriculum from elementary school through graduate school, and all major topic areas in mathematics (Davidson, 1989).

Cooperative Learning in Mathematics

Cooperative learning builds on and enhances the capacities of people to communicate and collaborate (Johnson, Murayama, Johnson, Nelson, and Skon 1981; Kohn 1986). It is a process of generating group relationships so that the group can support all of its members. Specific attention is paid to developing communication and group skills. Different roles are allocated, such as those of timekeeper and recorder, and rotated so that everybody participates in each role. The ideal is for the group to share the responsibility for the learning of each student in such a way that members want to help each other. Systematic and frequent use of small-group procedures has a profound positive effect upon the classroom climate (Slavin, 1991a); the classroom becomes a community of learners, actively working together in small groups to enhance each person's mathematical knowledge, proficiency, and enjoyment. Frequent use of small groups also has an enlivening and invigorating influence on the professional lives of mathematics teachers (Webb, 1989).

Of course, cooperative learning can become overstructrued and a veneer for excessive control. How it is implemented is a matter of the personality and style of the individual teachers. The key is to be true to the spirit of the process (Caine and Caine, 1993).

Rationale Young people have tremendous energy, yet school learning situations often require students to sit quietly and listen passively. The teacher must then exert strong control to keep the students quiet and on the task at hand; this takes an inordinate amount of time away from instruction and learning. Instead, why not mobilize students' energy levels by engaging them actively in the learning process? Moreover, human beings have strong affiliative needs for contact and communication with others (Johnson, Johnson, & Maruyama, 1983). Indeed, many students are motivated to come to school to be with their friends; they have a strong need to be accepted, to belong, and sometimes to influence others (Glasser, 1986). Yet school "discipline" is often designed to prevent students from talking to each other in class. In contrast, by setting up learning situations that foster peer interactions, the teacher meets a basic human need for affiliation and uses the peer group as a constructive force to enhance academic learning. How can active engagement in learning be combined with peer interaction? By letting students work together in small cooperative groups. Thus, cooperative learning makes use of basic characteristics of human nature. Therefore, it is not likely to be just another passing fad on the educational scene.

Cooperative Learning in Mathematics Instruction Why does cooperative learning have a place in mathematics instruction? Polya (1965) placed emphasis upon student thinking, active learning, discovery learning, and interest in mathematics. These factors are particular aspects of a general philosophy of education and of life, whose foremost advocate in education was John Dewey (1916, 1938). The learning of mathematics is often viewed as an isolated, individualistic matter. A student sits alone with paper, pencil, and perhaps calculator or computer and struggles to understand the material or solve the assigned problems. This process can be lonely and frustrating. Perhaps it is not surprising that many students and adults are afraid of mathematics. In contemporary language, they are troubled by math avoidance or math anxiety. They often believe that only a few talented individuals can compete successfully in the mathematical realm, whereas most of the humanity is fit only for a life of mathematical mediocrity or incompetence.

Small-group cooperative learning addresses these problems in several ways:

1. Small groups provide a social support mechanism for the learning of mathematics. Students have a chance to exchange ideas, to ask questions freely, to explain to one another, to clarify ideas, to help one another understand the ideas in a meaningful way, and to express feelings about their learning. This is part of the social dimension of learning mathematics.
2. Small-group learning offers opportunities for success for all students in mathematics (and in general). Students within groups are not competing one against another to solve problems. The group interaction is designed to help all members learn the ideas and problem-solving strategies.
3. Unlike many other types of problems in life, school mathematics problems can actually be solved in reasonable lengths of time, such as a class period. Moreover, mathematics problems are ideally suited for group discussion in that they have solutions that can be objectively shown. Students can persuade each other by the logic of their arguments.
4. Mathematics problems can often be solved by several different approaches. Students in groups can discuss the merits of different proposed solutions

and perhaps learn several strategies for solving the same problem.

5. Students in groups can help each other master facts and necessary computational procedures. These can often be dealt with in the more exciting aspects of mathematical learning through games, puzzles, or discussion of meaningful problems.

6. The role of small groups in mathematical communication is addressed in the Curriculum and Evaluation Standards for School Mathematics by the National Council of Teachers of Mathematics (1989):

> "Teachers foster communication in mathematics by asking questions or posing problem situations that actively engage students. Small-group work, large-group discussions, and presentation of individual and group reports - both written and oral - provide an environment in which students can practice and refine their growing ability to express mathematical thought processes and strategies. Small groups provide a forum for asking questions, discussing ideas, making mistakes, learning to listen to others' ideas, offering constructive criticism, and summarizing discoveries in writing. Whole-class discussions enable students to pool and evaluate ideas; they provide opportunities for recording data, sharing solution strategies, summarizing collected data, inventing notations, thinking, and constructing simple arguments."

<u>Motivation</u> Interest in mathematical topics and activities is intended to provide the major source of motivation. Problems are often given that arise in real life or in concrete physical situations, such as distance required to stop a car, spring displacement, radioactive decay, and profit or loss functions. An occational paradox is introduced, such as the arrow that never seems to hit the target because it always travels half of the remaining distance. Whenever possible, visual images are linked with and used to enliven symbolic expressions. Many situations involve a search for hidden patterns and

relationships in data.

The teacher attempts to determine which topics are of intrinsic value, which appear to be useful, and which have little interest or value from the student viewpoint. The ideal goal is to provide a learning environment in which all topics are perceived as interesting, valuable, or useful to the students.

The sequence of subject matter proceeds from the more concrete to the more abstract, as seen from the viewpoint of the learner. Abstract, theoretical considerations are postponed, pending the occurence of a good deal of concrete experience. Emphasis is placed upon the discovery of new ideas, more than upon the expression of the ideas in the most impeccable form. Professional standards of rigor are not imposed upon the beginner, and the initial development is informal in character. The need for increased precision and theoretical security becomes apparent to the students with the handling of increasingly difficult and abstract problems over the course of time. For example, the need for proofs or counterexamples becomes clear when there is genuine doubt about the truth of a conjecture. This is one of the greatest departures from more formal traditional teaching.

Skills are formed under conditions where thought is necessary. Whenever possible, the students themselves develop the techniques for solving each class of problems. The remaining practice occurs with problems that differ from one another and that require some judgment for the solutions. The skills are attained, whenever possible, by solving problems of intrinsic value for the students.

The teacher proposes problems and questions in order to guarantee that all major and essential topics are covered during the course. Within this basic framework provided by the teacher, many questions occur to the students. The investigation of student generated questions is a frequent activity of the class members.

Emphasis is placed on learning rather than upon evaluation. The teacher can often rely on students' internal sources of motivation, such as curiosity, interest in the mathematical topics or activities, and desire to develop a sense of competence or mastery. Some teachers may choose to reduce concern about external motivators such as grades by giving the students some voice in determining grading polcies, for example, the frequency, timing, and type of exams or projects.

Classroom Procedures A class period might begin with a meeting of the entire class to provide a general perspective. This may include a teacher presentation of new material, a class discussion, posing problems or questions for investigation, and clarifying directions for the group activities.

The class is then divided into small groups, usually with four members each. Each group has its own working space, which might include a flipchart or section of the chalkboard. Students work together cooperatively in each group to discuss mathematical ideas, solve problems, look for patterns and relationships in sets of data, make and test guesses, and so on. Students actively exchange ideas and help each other learn the material. The teacher takes an active role, circulating from group to group, providing assistance and encouragement, and asking thought-provoking questions as needed.

In each type of small group learning, there are many leadership and management functions that must be done. These are generally handled by the teacher, although some of them may be explicitly delegated to the students. The list of functions includes:

- Initiate group work
- Present guidelines for small group operations (such as the following: work

together in groups of four; cooperate with other group members; achieve a group solution for each problem; make sure that everyone understands the solution before the group goes on; listen carefully to others and try, whenever possible, to build upon their ideas; share the leadership of the group; make sure that everyone participates and no one dominates; take turn writing problem solutions on the board; proceed at a pace that is comfortable for your group)

- Foster group norms of cooperation and mutual helpfulness
- Form groups
- Prepare and introduce new material in some form: orally to the entire class; orally to separate groups, via written materials - worksheets, activity packages, text materials, and special texts designed for groups
- Interact with small groups in various possible ways: observe groups, check solutions, give hints, clarify notation, ask and sometimes answer questions, give specific feedback, point out errors, provide encouragement, reinforce social or group skills, help group function, furnish overall classroom management
- Tie ideas together - an overall synthesis by the teacher is needed from time to time, since students in the groups sometimes "see the trees but lose sight of the forest."
- Make assignment of homework or inclass work
- Evaluate student performance - A variety of grading schemes are compatible with small group instruction. These include inclass tests and

quizzes, takehome tests, group tests, group projects, homework, classwork (attendance, participation, cooperation), he or she should not grade individual mathematical performance during class-- doing so will foster competition and destroy group cooperation.

Each of these functions can be done in various ways and to varying degrees, depending upon the model of small-group instruction in effect. Additional ideas, in this regard, are as follows: structured positive interdependence, equal status interaction, assigned social roles, explicit processing on academic and social skills, perspective taking, and team building.

Research Outcomes The outcomes of cooperative learning methods have generally being quite favorable. Reviews of research have been presented by Sharan (1980), Slavin (1980, 1983a, 1983b, 1991a), Margolis, McCabe, & Schwartz (1990), and Johnson (1974, 1981, 1983, 1994). Reviews by Davidson (1985, 1989), and by Webb (1985, 1989) specifically address cooperative learning in mathematics.

Research has shown positive effects of cooperative learning in the following areas:

- Academic achievement
- Self-esteem or self-confidence as a learner
- Intergroup relations, including cross-race and cross-cultural friendships
- Social acceptance of mainstreamed children
- Ability to use social skills

Davidson (1989) reviewed more than 70 studies in mathematics comparing student achievement in cooperative learning versus whole-class traditional instruction. In more than 40 percent of these studies, students in the small-group approaches significantly outscored the control students on individual mathematical performance measures. In only two studies did the control students do better, and both these studies had design irregularities. This evidence might be reassuring to teachers who are concerned about the potential effects of cooperative learning methods on their students' achievement in mathematics.

The effects of cooperative learning of mathematical skills were consistently positive when there was a combination of individuals accountability and some form of team recognition for commendable team achievement. The effects of small-group learning were nonnegative (that is, not significantly different from traditional instruction) if the teacher had no prior experience in small-group learning, was not aware of well-established methods, and did very little to foster group cooperation or interdependence.

Defining Characteristics What are the defining characteristics (critical attributes) of small group cooperative learning in mathematics? The definition includes the following characteristics:

1. A mathematical task for group discussion and resolution (if possible)
2. Face-to-face interaction in small groups
3. An atmosphere of cooperation and mutual helpfulness within each group
4. Individual accountability

There is a debate about the requirement of heterogeneous or random grouping. Most of the researches advocate teacher-selected heterogeneous groups based on mathematical performance, race/ethnicity, and gender. However, some advocate random grouping; others prefer student choice of group members. Most would agree that homogeneous groups consisting of all slow learners or all high achievers do not work well for either range of performance.

Similarly, there is a debate about the teaching of social skills: Should these skills be explicitly modeled, practiced, and discussed? Does this depend on the extent to which students are already well versed in social skills?

Finally, there is a controversy about the degree of structuring mutual interdependence. How much interdependence is necessary for a group activity to be considered truly cooperative? Perhaps there is a continuum involving greater or lesser degree of interdependence. At one extreme are tasks that require ideas from all members - if one person withholds information, the task cannot be completed. At the opposite extreme are tasks that can be resolved by individuals - for example, individuals solving the same exercises and comparing results with their group members. Interdependence (called "positive interdependence" in the literature) can be structured in several ways.

The use of cooperative learning strategies can make classroom life for teachers and students more supportive, engaging, intellectually stimulating, creative, mathematically productive, and fun.

Innovative Uses of Traditional Methods

Language is powerful. There is much that cannot be expressed in language; yet, with some exceptions, the people who are best in their field are also people who can talk about it in many different ways. The native language is learnt by a partially random and partially orchestrated immersion in a variety of interactive experiences. Speaking and writing are ways of making those experiences understandable. That is one reason why it is so useful for a student to explain to a receptive parent what he/she did in a course, even if he/she does not feel confident about what he/she learned.

Every subject has a language of its own that needs to be mastered. At another level, language is a way of obtaining feedback from the environment. And at a still deeper level, language is a mediator between different systems and between conscious and unconscious mind. As Gazziniga (1985) says, "Language reports the cognitive computations of other mental modules" (p. 93). Deeper insights in part are acquired by an person as clearer ways to talk about and describe experience and what it means to him/her are found. It is not just a matter of getting the right answer. As a person talks about a subject or skill in complex and appropriate ways - and that includes making jokes and playing games - he/she actually begins to feel better about the subject and master it. That is why the everyday use of relevant terms and the appropriate use of language should be incorporated in every course from the beginning.

Practice is not excluded, but the extraordinary overemphasis on rote memorization is questioned. There are many challenging and stimulating ways to explore and rehearse. A wealth of resources and techniques in such forms as games, simulations, multimedia technologies, and the arts are available. Laughter and fun are not out of place when they are the results of immersion, as in the case of "fun drills" put together by students or a song written by the teacher.

CHAPTER 3

Methodology

Design of the Study

This study used the Solomon four-group design. It involved the random assignment of intact classes to two experimental groups and two comparison groups. Two of the groups were pretested and two were not; one pretested group and one unpretested group received instruction via cooperative learning strategies for five weeks. The remaining two groups received instruction via traditional methods also for five weeks. All four groups were posttested. The design takes the following form:

R	O_1	X_1	O_2
R	O_3	X_2	O_4
R		X_1	O_5
R		X_2	O_6

This design is a combination of the pretest-posttest control group design and the posttest only control group design, each of which has its own major source of invalidity (pretest treatment interaction and mortality, respectively). The combination of these two designs results in a design that controls for pretest treatment interaction and for mortality.

If the pretested experimental group does differently on the posttest than the unpretested experimental group, there is probably a pretest-treatment interaction. If no interaction is found, then the researcher can have more confidence in the generalizability of treatment differences.

The combination of random assignment and the presence of a pretest and a comparison group controls for all sources of internal validity. Random assignment controls for regression and selection factors; the pretest controls for mortality; randomization and the comparison group c ontrol for maturation; and the comparison group controls for history, testing, and instrumentation. Testing, for example is controlled because if pretesting leads to higher posttest scores, the advantage should be equal for both the experimental and comparison groups.

This is a simple 2 x 2 factorial design comprising of two active variables, viz. the method of instruction (A) and pretesting (B), as shown below:

	Experimental (a_1)	Comparison (a_2)
Pretest (b_1)	O_2	O_4
No Pretest (b_2)	O_5	O_6

Sample

The sample was selected from students enrolled in the Warren Campus of Detroit College of Business for Mathematics Skills 1 (MTH 1M1) during Fall, 1996. The participants in this research were those who scored below Grade Level 8.5 on the mathematics placement test. This course prepared students for Math of Finance or Beginning Algebra. It introduced and developed fundamental skills in numeric computations. Topics included basic arithmetic operations with whole numbers, fractions, decimals, and percentages and their applications. The Math Skills I carry four quarter hours of credit.

The population was multicultural, reflecting the diverse ethnic groups that comprise the tricounty area of Southeast Michigan. The participants were mainly at an upper-lower to middle class socioeconomic status. The number of females was about three times more than the males. There were more mature students, and the average age was 29. The number of enrollments for evening courses was more than for day courses.

All the students enrolled in the Warren Campus of Detroit College of Business for Mathematics Skills 1 (MTH 1M1) during Fall, 1996 were included in the study. Any student who wished not to take part in the study for whatever reason or who withdrew from the study at any time or refused to take the math pretest were referred to the Director of the Resource Lab for resolution.

Approximately 160 students participated in this study. There were eight classes having approximately twenty in each class. The classes were as follows:

A.	8:00 - 9:30	M/W	E.	8:00 - 9:30	T/R
B.	12:00 - 1:30	M/W	F.	12:00 - 1:30	T/R
C.	4:45 - 6:15p	M/W	G.	4:45 - 6:15p	T/R
D.	8:15 - 9:45p	M/W	H.	8:15 - 9:45p	T/R

The classes were randomly assigned to the four levels of the study.

Instruments

The Math portion of Tests of Adult Basic Education (TABE) Form 6 Level A was used as the pretest and the posttest for this research. The students were administered Test 3 which comprised 48 questions on Mathematics Computation, and Test 4 - Mathematics Concepts and Applications, which had 40 questions. They were given eighty minutes to complete both Test 3 and Test 4. The same instrument was administered at the beginning and at the end of the five-week period.

The instrument used for collection of data, being a published standardized achievement test, measured the status of subjects' proficiency in math. The technical data on the 1987 TABE presented in TABE Technical Report (1987) and the TABE Norms

Book (1987) shows KR-20 reliabilities ranging from 0.71 to 0.94, with a median of 0.89 and a mode of 0.90. According to test critiques, the 1987 TABE program is not yet a magnificent symphony orchestra that will do justice to a magnificent music hall, but it is close. Pending the arrival of TABE Forms 7 and 8, TABE Forms 5 and 6 can be recommended for adult programs aimed at diagnosing weak skills and measuring cognitive growth (Bauernfeind, 1986). According to the Eleventh Mental Measurements Yearbook (1992), the TABE, Forms 5 and 6, are well-done instruments with considerable justification for their use. The supporting material is nicely done, although the technical manual would benefit from considerable expansion, particularly with additional work on reliability and validity.

Hypothesis

This research attempted to answer the following hypotheses:

I. H_0: There is no significant pretest sensitization prevalent in educational studies.

H_1: There is significant pretest sensitization prevalent in educational studies.

II. H_0: There is no significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

H_1: There is a significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

The alpha level for the study was 0.05

Variables

The operational definitions for each level of the independent variables were:

Level one: The experimental group which was pretested and posttested and received instruction via cooperative learning strategies for five weeks.

Level two: The comparison group which was pretested and posttested and received traditional instruction for five weeks.

Level three: The experimental group which was only posttested and received instruction via cooperative learning strategies for five weeks.

Level four: The comparison group which was only posttested and received traditional instruction for five weeks.

The dependent variable analyzed in this study were the scores on the math portion of the TABE. The scale of measurement of the dependent variable was interval.

Data Collection

Following is a summary of the activities followed in collecting the research data. A letter requesting permission to conduct the study was sent to Detroit College of Business. Permission was granted to conduct the study during the fall term 1996 at the Warren Campus of the Detroit College of Business. Approval was also obtained from the Human Investigation Committee of Wayne State University to conduct the study. The enrollments for Math Skills 1 did not represent all of the geographic areas in the Southeast Michigan. Anonymity of subjects in this study was assured by the researcher through coding. The last four digits of the social security number of the students were used for coding to maintain confidentiality. The list was destroyed at the end of the study. All proper releases were obtained from the students before testing. Their responses to a demographic / support services awareness questionnaire were also obtained.

The results of the placement test were used as an indicator of their prior knowledge. The Survey Form of the TABE was used as the placement test and those who scored below Grade Level 8.5 were strongly recommended for Math Skills 1 and those scored Grade Level 8.5 and above but below Grade Level 10.5 were recommended for Math Skills 2.

TABE was administered as the pretest during the beginning of the week of September 23, 1996 to two classes in the experimental group and to two classes in the comparison group. The classroom instructors were asked to administer the instruments on the second day of classes. The researcher met with the instructors and provided directions to ensure consistency in providing instructions and overseeing completion of the instruments. The researcher collected the instruments following their completion. The pretest and the posttest were scored positively.

Eight instructors were assigned to the eight classes according to their choice. All the eight instructors were briefed about the study and the procedure. The four instructors in the comparison group were told to strictly follow the traditional method of instruction (incorporating the individualistic and competitive learning delivery strategies). Also, they were told that the achievements of the students do not reflect on the personality of the instructor but of the teaching method used. The four instructors in the experimental group were trained in the philosophy and procedures associated with the Cooperative Learning instructional delivery method. The training was completed on September 17, 1996 and lasted for approximately three hours. The details of the study were explained to the students on the first day of classes and their consent to participate in the study were obtained. The curriculum and the textbook used with all groups was the same. The text used for the course was Fundamentals of Mathematics, 6th. ed., Barker, Roger, Van Dyke. It came with computer software and a video. All instructors had more than five years of experience in teaching similar classes. All participants in this study had the same amount of instructional time in their respective classes.

The study began on the week of September 23, 1996 and continued for a seven-week period. On the second day of classes TABE was administered to two classes from the experimental group and to two classes from the comparison group. Following completion of the testing, students in the experimental groups were placed in cooperative groups, usually with four members each. The students in the experimental groups were randomly assigned to groups of four within each class. This ensured a better mix and was more businesslike. Let the chips fall where they may! Cooperative learning instructional delivery methods were used for a minimum of 30 minutes for each day of classes for the next five weeks.

The posttesting of mathematics computation and mathematics concepts and applications occurred toward the beginning of the week of November 4, 1996. All four groups were given the same posttest. All data collection was considered complete at the end of the posttest. Students absent or otherwise not present in the classroom were not included in the posttest. The procedures for the study were as follows:

DATE	TOPIC(S)	SECTIONS	ASSIGNMENTS
SEP. 17	MEETING WITH INSTRUCTORS		
SEP. 23/24 (DAY 1)	COURSE OUTLINE CONSENT FORM DEMOGRAPHIC QUESTIONNAIRE		
SEP. 25/26 (DAY 2)	PRETEST - administered to four classes only; it was a study day for the other four classes.		
SEP. 30 / OCT. 1 (DAY 3)	WHOLE NUMBERS, PRIMES AND MULTIPLES	1.1 TO 2.6 (CH. 1 & 2)	H.W. (1) / GR. W. (1)
OCT. 2/3 (DAY 4)	FRACTIONS AND MIXED NUMBERS	3.1 TO 3.8	QUIZ 1: H.W.(2) / GR. W. (2)
OCT. 7/8 (DAY 5)	FRACTIONS AND MIXED NUMBERS	3.9 TO 3.14	H.W. (3) / GR.W. (3)
OCT. 9/10 (DAY 6)	DECIMALS	4.1 TO 4.7	QUIZ 2; H.W.(4) /GR.W. (4)
OCT. 14/15 (DAY 7)	DECIMALS	4.8 TO 4.12	H.W. (5) / GR.W. (5)
OCT. 16/17 (DAY 8)	RATIO AND PROPORTIONS	5.1 TO 5.3 (CH. 5)	QUIZ 3; H.W.(6) /GR.W. (6)
OCT. 21/22 (DAY 9)	PERCENT	6.1 TO 6.8	H.W. (7) / GR.W. (7)
OCT. 23/24 (DAY 10)	GRAPHS	6.9 TO 6.11	QUIZ 4; H.W.(8) /GR.W. (8)
OCT. 28/29 (DAY 11)	MEASUREMENT APPENDIX II, III, V	7.1 TO 7.9	H.W. (9) / GR.W. (9)
OCT. 30/31 (DAY 12)	ALGEBRA PREVIEW: SIGNED NUMBERS APPENDIX IV - CALCULATORS	8.1 TO 8.7	QUIZ 5:H.W(10) / GR. W. (10)
NOV. 4/5 (DAY 13)	STUDY DAY		
NOV. 6/7 (DAY 14)	POSTTEST		

Data Analysis

The data collected from the surveys was entered into a computer file for analysis using SPSS 7.0 for Windows. The pretest and posttest TABE scores were added to the data file to measure the effects of treatment and pretesting. The first set of analyses compared the demographic variables to determine if the four groups differed in terms of learner characteristics. Where the variable was continuous, descriptive statistics, including means, standard deviations, and ranges, were used to describe the four groups and one-way analysis of variance was used to test for differences among the groups. Where the variables were categorical, cross tabulations by group membership were obtained, with chi-square analyses used to test for independence between the variable and group. Two questions on the demographic survey involved the use of multiple response to determine why participants enrolled in college classes and awareness of student support services available in the college. No testing was completed on these variables.

Prior to testing the hypotheses for this study, the two groups that were pretested were compared on their pretest scores using a t-test for two independent samples. As the participants were not randomly assigned to their groups, this test was necessary to determine if the groups differed on their mathematics ability as measured by the TABE prior to starting treatment.

The hypotheses were tested using the following procedure. A 2 X 2 factorial analysis of variance was used to compare posttest TABE scores by treatment and pretesting effect. Groups 1 and 3 and Groups 2 and 4 were collapsed to form the independent variable, treatment effect. Group 1 and Group 2 and Group 3 and Group 4 were collapsed to form the second independent variable, pretesting effect. These two variables were used as the independent variables in the factorial analysis of variance, with posttest scores on the TABE used as the dependent variable. Results of this analysis provided the two main effects and interaction effect of treatment X pretesting effect.

Dependent t-tests were used to test the effects of treatment for Groups 1 and 2 separately. The posttest scores for Groups 3 and 4 were compared using a t-test for two independent samples to test the effects of treatment on the two posttest only groups. Analysis of Covariance (ANCOVA) was carried out for groups 1 and 2 using the pretest scores as the covariate.

All decisions on the statistical significance of the findings were made using an alpha level of .05.

CHAPTER 4

Results of Data Analyses

Findings

Findings resulting from the statistical analyses performed on data collected from adults enrolled in the Warren Campus of Detroit College of Business for Mathematics Skills 1 (MTH 1M1) during Fall '96 are presented in this chapter. The first part presents the results of the descriptive statistical analysis, while the second part presents the results of the inferential statistical analysis relative to the hypotheses. Based on these analyses, there does not appear to be either a treatment effect or a testing effect on posttest scores of the TABE.

Descriptive Statistical Analysis

The age of the participants was obtained on the demographic questionnaire. Their responses were summarized using descriptive statistics. Ages were compared between the groups using a one-way analysis of variance. Table 1 presents results of this analysis.

Table 1

Age by Group

Group	Mean	SD	Median	Range		DF	F Ratio
				Minimum	Maximum		
1	27.19	9.48	25	18	48	3/117	0.50 (NS)
2	29.25	11.24	27	17	54		
3	30.64	11.26	28	18	60		
4	28.74	9.09	26	18	49		
Total	29.11	10.23	27	17	60		

The mean age of the students in the study was 29.11 (n = 121, sd=10.23 years), with a median of 27 years. The range of ages for the four groups was from a low of 17 years to a high of 60 years. The obtained F (df = 3/117) = 0.50 was not statistically significant at an alpha level of 0.05 indicating the ages of the students in each group were not different.

The students indicated their sex on the survey. Their responses were cross tabulated by group assignment. Table 2 presents the results of this analysis.

Table 2

Sex by Group

sex	Pretest/Posttest				Posttest Only				Total	
	Group 1		Group 2		Group 3		Group 4			
	N	%	N	%	N	%	N	%	N	%
Male	3	14	2	7.1	6	18	3	7.7	14	12
Female	18	86	26	93	27	82	36	92	107	88
Total	21	17	28	23	33	27	39	32	121	100
$\chi^2(3) = 2.67$ (NS)										

The number of females in the study (n=107, 88.4%) exceeded the number of males (n=14, 11.6%). As evidenced by the nonsignificant chi-square value of 2.67 (df=3, NS), the distribution of male and female students within the four groups did not differ among the four groups.

The students indicated their marital status on the survey. Their responses were cross tabulated by group assignment. Table 3 presents the results of this analysis. The number of singles in the study (n=80, 66.7%) exceeded the number of married (n=28, 23.3%) and the number of divorced or separated (n=12, 10.0%). As evidenced by the nonsignificant chi-square value of 4.85 (df=6, NS), the distribution of marital status of students within the four groups did not differ among the four groups.

Table 3

Marital Status by Group

Marital Status	Pretest/Posttest				Posttest Only				Total	
	Group 1		Group 2		Group 3		Group 4			
	N	%	N	%	N	%	N	%	N	%
Married	3	14.3	4	14.8	10	30.3	11	28.2	28	23.3
Single	17	81.0	20	74.1	19	57.6	24	61.5	80	66.7
Divorced/Separated	1	4.8	3	11.1	4	12.1	4	10.3	12	10.0
Total	21	17.5	27	22.5	33	27.5	39	32.5	120	100.0
$\chi^2(6) = 4.85$ (NS)										

The number of children of the participants was obtained on the demographic questionnaire. Their responses were summarized using descriptive statistics. The number of children was compared between the groups using a one-way analysis of variance. Table 4 presents results of this analysis.

Table 4

Number of Children by Group

Group	Mean	SD	Median	Range		DF	F Ratio
				Minimum	Maximum		
1	1.05	1.4	1	0	5	3/117	0.79 (NS)
2	1.61	1.87	1	0	8		
3	1.12	1.39	1	0	5		
4	1.15	1.31	1	0	4		
Total	1.23	1.49	1	0	8		

The mean number of children of the students in the study was one (n = 121, sd=1.49), with a median of one. The range of number of children for the four groups was from a low of zero to a high of eight. The obtained F (df = 3/117) = 0.79 was not statistically significant at an alpha level of 0.05 indicating that the number of children of the students in each group was not different.

The years between high school and first higher education class of the participants were obtained on the demographic questionnaire. Their responses were summarized using descriptive statistics. The years between high school and first higher education class of the participants were compared between the groups using a one-way analysis of variance. Table 5 presents results of this analysis.

Table 5

Years between high school and first higher education class by Group

Group	Mean	SD	Median	Range		DF	F Ratio
				Minimum	Maximum		
1	5.8	7.42	2	0	30	3/110	0.34 (NS)
2	6.65	8.44	4	0	28		
3	7.76	9.41	3	0	31		
4	7.97	8.72	5	0	30		
Total	7.24	8.58	4	0	31		

The mean of the years between high school and first higher education class of the students in the study was 7.24 (sd=8.58) years, with a median of 4 years. The range of years between high school and first higher education class for the four groups was from a low of .00 years to a high of 31 years. The obtained F (df = 3/110) = 0.34 was not statistically significant at an alpha level of 0.05 indicating the years between high school and first higher education class of the students in each group was not different.

The years since last math class of the participants were obtained on the demographic questionnaire. Their responses were summarized using descriptive statistics. The years since last math class of the participants were compared between the groups using a one-way analysis of variance. Table 6 presents results of this analysis.

Table 6

Years since last math class by Group

Group	Mean	SD	Median	Range		DF	F Ratio
				Minimum	Maximum		
1	6.7	7.69	2	0	30	3/112	0.70 (NS)
2	7.1	7.64	5	0	29		
3	8.91	9.06	6	0	31		
4	9.49	9.18	6	0	30		
Total	8.31	8.54	5	0	31		

The mean of the years since last math class of the students in the study was 8.31 (sd=8.54) years, with a median of 5 years. The range of the years since last math class for the four groups was from a low of .00 years to a high of 31 years. The obtained F (df = 3/112) = 0.70 was not statistically significant at an alpha level of 0.05 indicating that the years since last math class of the students in each group was not different.

The students indicated their employment status on the survey. Their responses were cross tabulated by group assignment. Table 7 presents the results of this analysis. The number of employed in the study (n=97, 80.2%) exceeded the number of unemployed (n=24, 19.8%). As evidenced by the significant chi-square value of 10.61 (df=3), at an alpha level of 0.05, the distribution of employed and unemployed students within the four groups did differ among the four groups.

Table 7

Employment status by Group

Employment	Pretest/Posttest				Posttest Only				Total	
	Group 1		Group 2		Group 3		Group 4			
	N	%	N	%	N	%	N	%	N	%
Employed	19	90.5	18	64.3	24	72.7	36	92.3	97	80.2
Not Employed	2	9.5	10	35.7	9	27.3	3	7.7	24	19.8
Total	21	17.4	28	23.1	33	27.3	39	32.2	121	100.0
$\chi^2(3) = 10.61^*$										

$^*p \leq .05$

The number of hours worked by the participants was obtained on the demographic questionnaire. Their responses were summarized using descriptive statistics. The number of hours worked by the participants was compared between the groups using a one-way analysis of variance. Table 8 presents results of this analysis.

Table 8

Hours worked by Group

Group	Mean	SD	Median	Range		DF	F Ratio
				Minimum	Maximum		
1	34	17.18	40	0	65	3/90	1.70
2	20.07	17.75	25	0	45		(NS)
3	29.19	21.21	40	0	60		
4	34.15	16.5	40	0	80		
Total	29.6	18.88	40	0	80		

The mean of the hours worked by the students in the study was 29.60 (n=90, sd=18.88 hours), with a median of 40 hours. The range of the number of hours worked by the participants for the four groups was from a low of .00 hours to a high of 80.00

hours. The obtained F (df = 3/90) = 1.70 was not statistically significant at an alpha level of 0.05 indicating the hours worked by the students in each group were not different.

The respondents were asked why they enrolled in a higher education program. They were given a list of 6 possible reasons for enrolling in these types of program. As the respondents were allowed to provide more than one response, the total number of responses exceeds the number of participants in the study. The positive responses to these reasons are presented by group membership in Table 9.

Table 9

Reasons for Enrolling in Higher Education Programs

Reasons for Enrolling in Higher Education Prgram	Pretest/Posttest				Posttest Only				Row Total	
	Group 1		Group 2		Group 3		Group 4			
	N	%	N	%	N	%	N	%	N	%
Better Job	13	65.0	16	57.1	24	75.0	20	51.3	73	61.3
Prepare for a Career	15	75.0	22	78.6	25	78.1	20	51.3	82	68.9
To get a Degree	1	5.0	0	0.0	1	3.1	3	7.7	5	4.2
New Career	7	35.0	9	32.1	11	34.4	19	48.7	46	38.7
Self Improvement	14	70.0	17	60.7	20	62.5	27	69.2	78	65.5
Other	3	15.0	12	42.9	0	0.0	3	7.7	18	15.1

Participants were asked to respond to the statement, "I am enrolled in higher education because I . . . " The majority of students (69%) indicated they were enrolled in the program because they wanted to prepare for a career, followed by self improvement (66%), a better job (61%) and a new career (39%). My boss wants me to get a degree and other were not priority reasons for enrolling in higher education as indicated by the low percent of 4 and 15 respectively.

The next set of variables is related to the respondents' awareness of student support services offered by the College. All participants were asked if their College offered specific student support services. They were given a list of 10 support services offered by the College. The positive responses to awareness of student support services are presented by group membership in Table 10.

Table 10

Awareness of Student Support Services

Awareness of student support services	Pretest/Posttest				Posttest Only				Row Total	
	Group 1		Group 2		Group 3		Group 4			
	N	%	N	%	N	%	N	%	N	%
Tutoring - Faculty	17	81.0	26	92.9	30	90.9	32	82.1	105	86.8
Tutoring - Peer	19	90.5	26	92.9	25	75.8	35	89.7	105	86.8
Computer Lab	20	95.2	25	89.3	33	100.0	38	97.4	116	95.9
Federal Pell Grant	19	90.5	26	92.9	28	84.8	32	82.1	105	86.8
College Work-Study Program	17	81.0	22	78.6	26	78.8	29	74.4	94	77.7
Federal Stafford Loan	17	81.0	23	82.1	27	81.8	28	71.8	95	78.5
Federal Plus Loan	12	57.1	15	53.6	19	57.6	19	48.7	65	53.7
Federal Supplemental Loan for Students	14	66.7	16	57.1	22	66.7	22	56.4	74	61.2
Scholarships	16	76.2	17	60.7	24	72.7	26	66.7	83	68.6
Veterans Benefits	5	23.8	7	25.0	12	36.4	13	33.3	37	30.6

Participants were asked to respond to the statement, "My college offers the following services." The majority of students (96%) indicated they were aware of the support services made available in the college by the Computer Lab, followed by Tutoring - Faculty (87%), Tutoring - Peer (87%), Federal Pell Grant (87%), Federal Stafford Loan (79%), College Work-Study Programs (78%), Scholarships (69%), Federal Supplemental Loan for Students (61%), and Federal Plus Loan (54%). The students indicated they were least aware of Veterans benefits (31%) for students who qualified.

The second component of Chapter 4 presents the results of the inferential tests used to make decisions on the hypotheses.

Inferential Statistical Analysis

Prior to testing the hypotheses for this study, the two groups that were pretested were compared on their pretest scores using a t-test for two independent samples. As the participants were not randomly assigned to their groups, the test was necessary to determine if the groups differed on their mathematics ability as measured by the TABE prior to starting the treatment.

The groups tested were the experimental group that was pretested and posttested and received instruction via cooperative learning strategies for five weeks (Group 1) and the comparison group that was pretested and posttested and received traditional instruction for five weeks (Group 2). The dependent measures used were the scores on the pretest of TABE. The results of the t-test are shown in Table 11.

Table 11

t-Test for Two Independent Samples
for the Pretest by Group Membership

Pretest	N	Mean	Std. Dev.	df	t value	Prob. of t
Group 1	21	751..05	20.85	47	-0.73	0.47
Group 2	28	754.89	16.14			

The t-test for two independent samples for pretest scores provided nonsignificant statistical results. The pretest scores for Groups 1 and 2 achieved a t-value of -0.73 ($df=47$, $p \geq 0.05$) which was not statistically significant. The mean for the experimental group was 751.05 ($sd=20.85$) that compared to the mean score of 754.89 ($sd=16.14$) for comparison group. These results indicated that Group 1 and Group 2 did not differ on their mathematics ability as measured by the TABE prior to starting treatment.

<u>Hypothesis One</u> There is no significant pretest sensitization prevalent in educational studies.

<u>Hypothesis Two</u> There is no significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

The above hypotheses were tested using the following procedure. A 2 X 2 factorial analysis of variance was used to compare posttest TABE scores by treatment and pretesting effect. The experimental group which was pretested and posttested and received instruction via cooperative learning strategies for five weeks (Group 1) and the experimental group which was only posttested and received instruction via cooperative learning strategies for five weeks (Group 3) were collapsed and the comparison group which was pretested and posttested and received traditional instruction for five weeks (Group 2) and the comparison group which was only posttested and received traditional instructions for five weeks (Group 4) were collapsed to form the independent variable, treatment effect. Groups 1 and 2 and Groups 3 and 4 were collapsed to form the second independent variable, pretesting effect. These two variables were used as the independent variables in a factorial analysis of variance, with posttest scores on the TABE used as the dependent variable. The results of the analysis of variance are presented in Table 12.

The interaction between treatment and pretesting of the student yielded an F ratio of 0.63 which was not statistically significant at an alpha level of 0.05 with 1 and 117 degrees of freedom. The F ratio of 1.85 for the treatment yielded a statistically nonsignificant result at an alpha level of 0.05 with 1 and 117 degrees of freedom. The F ratio of 0.85 for pretesting was not statistically significant at an alpha level of 0.05 with 1 and 117 degrees of freedom which indicated that pretest, regardless of the treatment, did not produce different levels of achievement. This result indicated that the scores on the posttest of TABE did not differ based on the pretesting or treatment.

Table 12

Factorial Analysis of Variance of
Posttest Scores on the TABE by
Treatment Effect and Pretesting Effect of Students

Source of Variation	Sum of Squares	DF	Mean Square	F Ratio	Prob of F
Main Effects:					
Treatment	847.35	1	847.35	1.85	0.18
Pretesting	389.31	1	389.31	0.85	0.36
Interaction of Treatment X Pretesting	1619.23	1	1619.23	3.54	0.06
Residual	53509.26	117	457.34		
Total	56365.15	120			

The posttest TABE scores were summarized using descriptive statistics. Table 13 presents the results of this analysis. The mean posttest TABE score of the students in the study was 776.79 (sd = 21.56), with a median of 783.00. The range of scores for the posttest of four groups was from a low of 687.00 to a high of 797.00.

A dependent t-test was used to test the achievement level for Group 1. The results of this analysis are shown in Table 14.

The result of the correlated t-test for Group 1 having pretest and posttest TABE scores was statistically significant. The pretest and the posttest achieved a t-value of -4.54

(df=20, p<.05) which was statistically significant. The mean for the pretest of the experimental group was 751.05 (sd=20.85) which compared to the mean score of 767.81 (sd=31.56) for the posttest of the same group. The correlation between the pretest and the posttest was significant having an r value of 0.70. These results indicated that the gain in math achievement scores by the students in the experimental group 1 was significant.

Table 13

Posttest TABE Statistics by Group

Group	N	Mean	SD	Median	Range	
					Minimum	Maximum
1	21	767.81	31.56	784.00	687.00	797.00
2	28	780.75	14.08	782.50	743.00	797.00
3	33	779.00	15.91	782.00	731.00	796.00
4	39	776.92	23.02	786.00	707.00	797.00
Total	121	776.79	21.56	783.00	687.00	797.00

Table 14

Paired t-Test for Group 1

	N	Mean	Std. Dev.	Corr.	df	t value	Prob. of t
Pretest	21	35.43	7.64	0.70	20	-4.54*	0.00
Posttest	21	46.48	15.11				

*p ≤ .05

A dependent t-test was used to test the level of achievement for Group 2. The results of this analysis are shown in Table 15.

The results of the correlated t-test for the Group 2 having pretest and posttest TABE scores provided a statistically significant result. The pretest and the posttest achieved a t-value of -9.98 (df=28, p<.05) which was statistically significant. The mean for the pretest of the comparison group was 754.89 (sd=16.14) which compared to the mean score of 780.75 (sd=14.08) for the posttest of the same group. The correlation between the pretest and the posttest was significant having r = 0.56. These results indicated that the gain in mathematics achievement by the students in the comparison group 2 was significant.

Table 15

Paired t-Test for Group 2

	N	Mean	Std. Dev.	Corr.	df	t value	Prob. of t
Pretest	28	36.61	6.14	0.56	27	-9.98*	0.00
Posttest	28	51.50	9.46				

*p ≤ .05

Table 16

t-Test for Two Independent Samples
for the Posttest by Group Membership

Posttest	N	Mean	Std. Dev.	df	t value	Prob. of t
Group 3	33	779.00	15.91	70	0.44	0.66
Group 4	39	776.92	23.02			

The posttest scores for Groups 3 and 4 were compared using a t-test for two independent samples to test the effects of treatment on the two posttest only groups. The groups tested were the experimental group which was posttested only and received instruction via cooperative learning strategies for five weeks (Group 3) and the comparison group which was posttested only and received traditional instruction for five weeks (Group 4). The dependent measures used were the scores on the posttest. The results of the t-test are shown in Table 16. The results of the t-test for the two independent samples for the posttest scores provided nonsignificant statistical results. The comparison of posttest scores yielded a t-value of 0.44 (df=70, p>0.05) which was not statistically significant. The mean for the experimental group was 779.00 (sd=15.91) which compared to the mean score of 776.92 (sd=23.02) for the comparison group. These results indicated that the two groups did not differ on their mathematics ability as measured by the TABE after the treatment.

An analysis of covariance was carried out for Groups 1 and 2, using pretest scores as the covariate. The results of the analysis are presented in Table 17.

Table 17

Analysis of Covariance of
Posttest Scores on the TABE for Groups 1 and 2 by
Treatment Effect and Pretesting Effect of Students with Pretest Scores as the Covariate

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Probability of F
Between (adj)	1150.49	1	1150.49	3.51	0.07
Residual	15094.73	46	328.15		
Total (adj)	16245.22	47			

The obtained F ratio of 3.51 (df=1/46, p=.07) for adjusted means of the posttest scores on the TABE for Groups 1 and 2, having the pretest scores on the TABE as the covariate, was statistically not significant at an alpha level of 0.05.

Based on these analyses, there does not appear to be either a treatment effect or a testing effect on posttest scores of the TABE. As a result of the lack of significant findings, the null hypotheses one and two are retained.

Summary

Chapter 4 has presented the results of the data analysis used to describe the sample and answer the research questions. The conclusions and recommendations based on these findings are presented in Chapter 5.

CHAPTER 5

Summary, Conclusions, and Recommendations

Summary

Assessment occurs at the intersection of the important knowledge taught with how it is taught, what is learned, and how it is learned. It is a dynamic process that continuously yields information about student progress toward the achievement of the desired knowledge. When the information gathered is consistent with learning goals and is used appropriately to inform teaching, it can direct future learning, and document it. The process of gathering evidence to make inferences about student learning, provides to students and all of those concerned with their learning, a sample of what is valued. It also provides information on how students are progressing toward specific goals based on that sampling.

Pretests are also administered before instruction, and results are used to establish a baseline. It could also be used to help decide which instructional materials are options. The teacher can use this information to plan review for any skills previously mastered and to develop lessons emphasizing skills that remain to be learned. Pretest data can also be used to group students who already have mastered most of the enabling skills and students who have not.

However, pretests can "inform" students about what is to come and affect their later scores, by that decreasing the internal validity of a study. Similarly, the presence of a pretest can change the nature of the treatment, so that the treatment applied to another setting is less or more effective without the presence of the pretest. To make things equivalent and maximize generalizability to other settings, the pretest would have to be experiment's purpose (Salkind, 1991).

The purpose of the study was to find out whether there was a significant pretest effect in the achievement level of adult students who were subjected to cooperative learning strategies as opposed to traditional teacher-centered instruction. Whereas pretest effects are well known and studied in psychology interventions for constructs such as personality, cognitive outcomes, and attitude outcomes, it is not known if pretest effects are prevalent in educational studies.

This research attempted to answer the following hypotheses:

I. H_0: There is no significant pretest sensitization prevalent in educational studies.

H_1: There is significant pretest sensitization prevalent in educational studies.

II. H_0: There is no significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

H_1: There is a significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods.

Pretesting is more likely to be a threat when the time between pretesting and posttesting is short. Pretest sensitization is also more likely to occur in some studies than in others. Because analysis of several research reports has shown that pretesting can be a problem in any study, the decision to use a pretest should not be made lightly (Willson & Putnam, 1982). If a pretest is used when dealing with educational variables, it is not clear whether a design should be selected which controls for pretesting. Therefore, if confounding due to the pretest can be ignored safely, then school districts can use them with cooperative learning strategies with greater confidence.

Suppose the pretest-posttest design with a treatment group and a control group is used and potential limitations on interpretation such as history, maturation, and the other factors cited in Chapter 1 are ruled out. The analysis can be refined by assessing subjects and environments on many different kinds of variables (and finding the contributions of these variables to explained variance on the dependent variable), or the situation can be closely controlled to limit external influences. In reality, of course, the problem cannot be eliminated, but rather, the researcher can only be aware of them and consider when the results are interpreted.

One method of analysis makes use of change or difference scores for subjects who are exposed to the pretest and the posttest. That is, the mean of the difference between the pretest and the posttest scores of the treatment group is compared with the mean of the difference between the pretest and the posttest for the control group and tests whether the differences are significantly different. In essence, the measure that would be the unit of analysis is the change or difference score. However, the use of change or difference scores is not a good strategy because a difference score is derived from the premeasures and the postmeasures and the difference score usually is correlated with the pretest and posttest and is also less reliable than the original measure. The analytical strategy used in this study to find the effect of an intervention is a simple 2 x 2 analysis of variance design along with analysis of covariance, having pretest score as the covariate.

Chapter 2 presented a review of related literature. At the present time, sharp differences of opinion exist concerning the possible and probable consequences of giving students a test before the commencement of instruction. Researchers are unclear about the effects of such pretests on subsequent learning (if any), and they are also unclear about the effects of such tests on further tests (of varying degrees of similarity and difference) given after instructional sessions. There is evidence that pretests can have orienting and motivational and (hence) teaching functions, in addition to the sought for testing function. There is also evidence that these additional functions can be either general or specific.

There appear to have been three kinds of results obtained in studies on the effects of pretesting:

(i) pretest effects have not been discernible;

(ii) pretest effects have been specific: i.e., subjects have scored highest on posttest questions that have previously appeared in the pretest but no higher than control subjects on other questions; and

(iii) in some studies pretest effects have, in addition, generalized, i.e., subjects (usually) have scored highest on posttest items that have appeared in the pretest, but have also scored higher on other questions than have control subjects who have not done a pretest.

From examining the research literature, it appears that the important variables appear to be:

(i) the length and quality of the instruction,

(ii) the relevance of the pretest,

(iii) the age, ability and experience of the students involved.

In most studies where pretest effects have been found, the instructional situation has been relatively short. Pretest effects were found with brief exposures to the treatment compared with long exposures. In addition, it needs to be reiterated that the quality of the instruction is an important variable. In cases where the instruction is efficient - where all students learn to criterion, then, even if they exist, pretest effects cannot manifest themselves, but where the instruction is less efficient and/or where the students have to organize the materials for themselves, then pretest effects may be manifested. It seems unlikely that it is of much value to give a student a pretest on material about which he knows very little.

Monte Carlo studies provide information that can assist researchers in selecting a statistical test when underlying assumptions of the test are violated. Effective use of this literature is hampered by the lack of an overarching theory to guide the interpretation of Monte Carlo studies. The problem is exacerbated by the impressionistic nature of the studies, which can lead different readers to different conclusions. These shortcomings can be addressed using meta-analytic methods to integrate the results of Monte Carlo studies. Quantitative summaries of the effects of assumption violations on the Type I error rate and power of a test can assist researchers in selecting the best test for their data. Such summaries can also be used to evaluate the validity of previously published statistical results (Harwell, 1992).

The acceleration in the production, adaptation, dissemination and the impact of knowledge has created a massive need for education of adults. The changes occurring in various sectors of the contemporary world are creating a need for adults to develop the means for dealing with it. The education of adults has thus become a social necessity. A sector most affected by these profound changes is that of education itself: schooling, professional education, the education of adults, social and cultural work, special education, and continuing education. Furthermore, it is this sector that is called upon to develop and carry out new policies and practices required by society in dealing with these massive changes.

There are four problematic areas in the field of adult education:

- the relation of the education of adults to the just and wise government of society;
- the velocity of knowledge production and the capacity for its integration;
- the implications for the above in the transformation of industrial society to post industrial society;
- individual and collective human behavior in the tension between knowledge production and its integration.

The treatment strategy the adults are subjected to in this study is cooperative learning and the content area is mathematics. Small-group cooperative learning provides an alternative to both traditional whole-class expository instruction and individual instruction systems. The procedures described are realistic, practical strategies for using small groups in mathematics teaching and learning. These methods can be applied with all age levels of students, all levels of the mathematics curriculum from elementary school through graduate school, and all major topic areas in mathematics (Davidson, 1989).

Cooperative learning builds on and enhances the capacities of people to communicate and collaborate (Johnson, Maruyama, Johnson, Nelson, & Skon 1981; Kohn 1986). It is a process of generating group relationships so that the group can support all of its members. Specific attention is paid to developing communication and group skills. Different roles are allocated, such as those of timekeeper and recorder, and rotated so that everybody participates in each role. The ideal is for the group to share the responsibility for the learning of each student in such a way that members want to help each other. Systematic and frequent use of small-group procedures has a profound positive effect upon the classroom climate (Slavin, 1991a); the classroom becomes a community of learners, actively working together in small groups to enhance each person's mathematical knowledge, proficiency, and enjoyment. Frequent use of small groups also has an enlivening and invigorating influence on the professional lives of mathematics teachers (Webb, 1989).

Interest in mathematical topics and activities is intended to provide the major source of motivation. Problems are often given that arise in real life or in concrete physical situations, such as distance required to stop a car, spring displacement, radioactive decay, and profit or loss functions. An occasional paradox is introduced, such as the arrow that never seems to hit the target because it always travels half of the remaining distance. Whenever possible, visual images are linked with and used to enliven symbolic expressions. Many situations involve a search for hidden patterns and relationships in data.

The teacher attempts to determine which topics are of intrinsic value, which appear to be useful, and which have little interest or value from the student viewpoint. The ideal goal is to provide a learning environment in which all topics are perceived as interesting, valuable, or useful to the students.

The sequence of subject matter proceeds from the more concrete to the more abstract, as seen from the viewpoint of the learner. Abstract, theoretical considerations are postponed, pending the occurrence of a good deal of concrete experience. Emphasis is placed upon the discovery of new ideas, more than upon the expression of the ideas in the most impeccable form. Professional standards of rigor are not imposed upon the beginner, and the initial development is informal in character. The need for increased precision and theoretical security becomes apparent to the students with the handling of increasingly difficult and abstract problems over the course of time. For example, the need for proofs or counter examples becomes clear when there is genuine doubt about the truth of a conjecture. This is one of the greatest departures from more formal traditional teaching.

Skills are formed under conditions where thought is necessary. Whenever possible, the students themselves develop the techniques for solving each class of problems. The remaining practice occurs with problems that differ from one another and that requires some judgment for the solutions. The skills are attained, whenever possible, by solving problems of intrinsic value for the students.

The teacher proposes problems and questions in order to guarantee that all major and essential topics are covered during the course. Within this basic framework provided by the teacher, many questions occur to the students. The investigation of student generated questions is a frequent activity of the class members.

Emphasis is placed on learning rather than upon evaluation. The teacher can often rely on students' internal sources of motivation, such as curiosity, interest in the mathematical topics or activities, and desire to develop a sense of competence or mastery. Some teachers may choose to reduce concern about external motivators such as grades by giving the students some voice in determining grading polices, for example, the frequency, timing, and type of exams or projects.

The outcomes of cooperative learning methods have generally being quite favorable. Reviews of research have been presented by Sharan (1980), Slavin (1980, 1983a, 1983b, 1991a), Margolis, McCabe, & Schwartz (1990), and Johnson (1974, 1981, 1983, 1994). Reviews by Davidson (1985, 1989), and by Webb (1985, 1989) specifically address cooperative learning in mathematics.

Research has shown positive effects of cooperative learning in the following areas:

- Academic achievement
- Self-esteem or self-confidence as a learner
- Intergroup relations, including cross-race and cross-cultural friendships
- Social acceptance of mainstreamed children
- Ability to use social skills

Davidson (1989) reviewed more than 70 studies in mathematics comparing student achievement in cooperative learning versus whole-class traditional instruction. In more than 40% of these studies, students in the small-group approaches significantly outscored the control students on individual mathematical performance measures. In only two studies did the control students do better, and both these studies had design irregularities. This evidence might be reassuring to teachers who are concerned about the potential effects of cooperative learning methods on their students' achievement in mathematics.

The effects of cooperative learning of mathematical skills were consistently positive when there was a combination of individuals accountability and some form of team recognition for commendable team achievement. The effects of small-group learning were nonnegative (that is, not significantly different from traditional instruction) if the teacher had no prior experience in small-group learning, was not aware of well-established methods, and did very little to foster group cooperation or interdependence. The use of cooperative learning strategies can make classroom life for teachers and students more supportive, engaging, intellectually stimulating, creative, mathematically productive, and fun.

Chapter 3 outlined the methodology of this research. This study used the Solomon four-group design. It involved the random assignment of eight intact classes to four treatment groups. Eight teachers were randomly assigned to the eight classes. Two of the groups were pretested and two were not; one pretested group and one unpretested group received instruction via cooperative learning strategies for five weeks. The remaining two groups received instruction via traditional methods also for five weeks. All four groups were posttested.

This design is a combination of the pretest-posttest control group design and the posttest only control group design, each of which has its own major source of invalidity (pretest treatment interaction and mortality, respectively). The combination of these two designs results in a design that controls for pretest treatment interaction and mortality.

If the pretested experimental group does differently on the posttest than the unpretested experimental group, there is probably a pretest-treatment interaction. If no interaction is found, then the researcher can have more confidence in the generalizability of treatment differences.

The combination of random assignment and the presence of a pretest and a comparison group controls for all sources of internal validity. Random assignment controls for regression and selection factors; the pretest controls for mortality; randomization and the comparison group control for maturation; and the comparison group controls for history, testing, and instrumentation. Testing, for example is controlled because if pretesting leads to higher posttest scores, the advantage should be equal for both the experimental and comparison groups.

The sample was selected from students enrolled in the Warren Campus of Detroit College of Business for Mathematics Skills 1 (MTH 1M1) during Fall, 1996. The participants in this research were those who scored below Grade Level 8.5 on the mathematics placement test. This course prepared students for Math of Finance or Beginning Algebra. It introduced and developed fundamental skills in numeric computations. Topics included basic arithmetic operations with whole numbers, fractions, decimals, and percentages and their applications. The Math Skills I carry four quarter hours of credit.

The population was multicultural, reflecting the diverse ethnic groups that comprise the tricounty area of Southeast Michigan. The participants were mainly at an upper-lower to middle class socioeconomic status. The number of females was about three times more than the males. There were more mature students, and the average age was 29. The number of enrollments for evening courses was greater than for day courses.

All the students enrolled in the warren campus of Detroit College of Business for Mathematics Skills 1 (MTH 1M1) during Fall, 1996 were included in the study. Out of one hundred sixty nine (169) students who participated in the study, only one hundred twenty one (121) students completed the study. The classes were randomly assigned to the four groups of the study. The Math portion of Tests of Adult Basic Education (TABE) Form 6 Level A was used as the pretest and the posttest for this research. The students were administered Test 3 which included 48 questions on Mathematics Computation, and Test 4 - Mathematics Concepts and Applications, which had 40 questions. They were given 80 minutes to complete both Test 3 and Test 4. The same instrument was administered at the beginning and at the end of the five-week period.

The study began on the week of September 23, 1996 and continued for a seven-week period. On the second day of classes TABE was administered to two classes from the experimental group and to two classes from the comparison group. Following completion of the testing, students in the experimental groups were placed in cooperative groups, usually with four members each. The students in the experimental groups were randomly assigned to groups of four within each class. This ensured a better mix and was more businesslike. Cooperative learning instructional delivery methods were used for a minimum of 30 minutes for each day of classes for the next five weeks. The posttesting of mathematics computation and mathematics concepts and applications occurred during the beginning of the week of November 4, 1996. All four groups were given the same posttest. All data collection was considered complete at the end of the posttest. Students absent or otherwise not present in the classroom were not included in the posttest.

The data collected from the surveys was entered into a computer file for analysis using SPSS 7.0 for Windows. The pretest and posttest TABE scores were added to the data file to measure the effects of treatment and pretesting. The first set of analyses compared the demographic variables to determine if the four groups differed in terms of learner characteristics. Where the variable was continuous, descriptive statistics, including means, standard deviations, and ranges, were used to describe the four groups and one-way analysis of variance was used to test for differences among the groups. Where the variables were categorical, cross tabulations by group membership were obtained, with chi-square analyses used to test for independence between the variable and group. Two questions on the demographic survey involved the use of multiple response to determine why participants enrolled in college classes and awareness of student support services available in the college. No testing was completed on these variables.

Prior to testing the hypotheses for this study, the two groups that were pretested were compared on their pretest scores using a t-test for two independent samples. As the participants were not randomly assigned to their groups, this test was necessary to determine if the groups differed on their mathematics ability as measured by the TABE prior to starting treatment.

The hypotheses were tested using the following procedure. A 2 x 2 factorial analysis of variance was used to compare posttest TABE scores by treatment and pretesting effect. Groups 1 and 3 and Groups 2 and 4 were collapsed to form the independent variable, treatment effect. Groups 1 and 2 and Groups 3 and 4 were collapsed to form the second independent variable, pretesting effect. These two variables were used as the independent variables in the factorial analysis of variance, with posttest scores on the TABE used as the dependent variable. Results of this analysis provided the two main effects and interaction effect of treatment x pretesting.

Dependent t-tests were used to test the effects of treatment for Groups 1 and 2 separately. The posttest scores for Groups 3 and 4 were compared using a t-test for two independent samples to test the effects of treatment on the two posttest only groups. All decisions on the statistical significance of the findings were made using an alpha level of 0.05.

Chapter 4 carried the results of data analysis. The mean age of the students in the study was 29.11 (sd=10.23 years), with a median of 27 years. The range of ages for the four groups was from a low of 17 years to a high of 60 years. The obtained F (df = 3/117) = 0.50 was not statistically significant at an alpha level of 0.05 indicating the ages of the students in each group were not different.

The number of females in the study (n=107, 88.4%) exceeded the number of males (n=14, 11.6%). As evidenced by the nonsignificant chi-square value of 2.67 (df=3, NS), the distribution of male and female students within the four groups did not differ among the four groups.

The number of singles in the study (n=80, 66.7%) exceeded the number of married (n=28, 23.3%) and the number of divorced or separated (n=12, 10.0%). As evidenced by the nonsignificant chi-square value of 4.85 (df=6, NS), the distribution of marital status of students within the four groups did not differ among the four groups.

The mean number of children of the students in the study was 1 (n = 121, sd=1.49), with a median of 1. The range of number of children for the four groups was from a low of zero to a high of eight. The obtained F (df = 3/117) = 0.79 was not statistically significant at an alpha level of .05 indicating that the number of children of the students in each group was not different.

The mean of the years between high school and first higher education class of the students in the study was 7.24 (sd=8.58) years, with a median of 4 years. The range of years between high school and first higher education class for the four groups was from a low of zero years to a high of 31 years. The obtained F (df = 3/110) = 0.34 was not statistically significant at an alpha level of 0.05 indicating the years between high school and first higher education class of the students in each group was not different.

The mean of the years since last math class of the students in the study was 8.31 (sd=8.54) years, with a median of 5 years. The range of the years since last math class for the four groups was from a low of .00 years to a high of 31 years. The obtained F (df = 3/112) = .70 was not statistically significant at an alpha level of .05 indicating that the years since last math class of the students in each group was not different.

The number of students who were employed in the study (n=97, 80.2%) exceeded the number of unemployed (n=24, 19.8%). As evidenced by the significant chi-square value of 10.61 (df=3), at an alpha level of 0.05, the distribution of employed and unemployed students within the four groups did differ among the four groups.

The mean of the hours worked by the students in the study was 29.60 (n= 90, sd=18.88 hours), with a median of 40 hours. The range of the number of hours worked by the participants for the four groups was from a low of .00 hours to a high of 80.00 hours. The obtained F(df = 3/90) = 1.70 was not statistically significant at an alpha level of 0.05 indicating the hours worked by the students in each group were not different.

Participants were asked to respond to the statement, "I am enrolled in higher education because I . . . " The majority of students (69%) indicated they were enrolled in the program because they wanted to prepare for a career, followed by self improvement (66%), a better job (61%) and a new career (39%). My boss wants me to get a degree and other were not priority reasons for enrolling in higher education as indicated by the low percent of 4 and 15 respectively.

Participants were asked to respond to the statement, "My college offers the following services." The majority of students (96%) indicated they were aware of the support services made available in the college by the Computer Lab, followed by Tutoring - Faculty (87%), Tutoring - Peer (87%), Federal Pell Grant (87%), Federal Stafford Loan (79%), College Work-Study Programs (78%), Scholarships (69%), Federal Supplemental Loan for Students (61%), and Federal Plus Loan (54%). The students indicated least awareness of support services made available to the Veterans (31%).

The results of the t-test for the two independent samples for the pretest score provided nonsignificant statistical results. The pretest scores for Groups 1 and 2 achieved a t-value of -0.73 which was not statistically significant at an alpha level of 0.05 with 47 degrees of freedom. The mean for the experimental group was 751.05 with a standard deviation of 20.85 which compared to the mean score of 754.89 with a standard deviation of 16.14 for the comparison group. These results indicated that the two groups did not differ on their mathematics ability as measured by the TABE prior to starting treatment.

The interaction between treatment and pretesting of the student yielded an F ratio of 3.54 which was not statistically significant at an alpha level of 0.05 with 1 and 117 degrees of freedom. The F ratio of 1.85 for the treatment yielded a statistically nonsignificant result at an alpha level of 0.05 with 1 and 117 degrees of freedom.. The F ratio of 0.85 for pretesting was not statistically significant at an alpha level of 0.05 with 1 and 117 degrees of freedom which indicated that pretest, regardless of the treatment, did not produce different levels of achievement. This result indicated that the scores on the posttest of TABE did not differ based on the pretesting or treatment.

The correlated t-test for the Group 1 having pretest and posttest TABE scores provided a statistically significant result. The pretest and the posttest achieved a t-value of -4.54 which was statistically significant at an alpha level of 0.05 with 20 degrees of freedom. The mean for the pretest of the experimental group was 751.05 (sd=20.85) which compared to the mean score of 767.81 (sd=31.56) for the posttest of the same group. The correlation between the pretest and the posttest was significant having r = 0.70. These results indicated that the achievement level of the students was significant.

The correlated t-test for the Group 2 having pretest and posttest TABE scores provided a statistically significant result. The pretest and the posttest achieved a t-value of -9.98 which was statistically significant at an alpha level of 0.05 with 27 degrees of freedom. The mean for the pretest of the comparison group was 754.89 (sd=16.14) which compared to the mean score of 780.75 (sd=14.08) for the posttest of the same group. The correlation between the pretest and the posttest was significant having r = 0.56. These results indicated that the achievement level of the students was significant.

The results of the t-test for the two independent samples (Groups 3 and 4) for the posttest scores provided nonsignificant statistical results. The posttest achieved a t-value of 0.44 which was not statistically significant at an alpha level of 0.05 with 70 degrees of freedom. These results indicated that the two groups did not differ on their mathematics ability as measured by the TABE after the treatment.

Based on the analysis of covariance, the obtained F ratio of 3.51 (df=1/46, p=.07) for adjusted means of the posttest scores on the TABE for Groups 1 and 2, having the pretest scores on the TABE as the covariate, was statistically not significant at an alpha level of 0.05.

Based on these analyses, there does not appear to be either a treatment effect or a testing effect on posttest scores of the TABE. As a result of the lack of significant findings, the null hypotheses one and two are retained.

Discussion

This study investigated the effects of pretest sensitization associated with cooperative learning strategies on the achievement level of adult mathematics students. There was no pretest-treatment interaction ($O_2 = O_5 = O_4 = O_6$). The study retained the null hypothesis that there was no significant pretest sensitization prevalent in the current educational study ($O_2 = O_5$; $O_4 = O_6$). The study also retained the null hypothesis that there was no significant difference between the achievement level of students who received instruction via cooperative learning strategies and the achievement level of students who received instruction via traditional methods ($O_2 = O_4$; $O_5 = O_6$). However, the increase in the level of achievement was significant among the groups who were both pretested and posttested ($O_2 > O_1$; $O_4 > O_3$). The structural model for the study was:

$$Y = \mu + \alpha + \beta + \alpha\beta + e.$$

Factors such as age, grade point average, intelligence, previous experience in math, motivation, attitude, need, stimulation, competence, reinforcement and aptitude may have contributed to the large error term (unexplained variation). There was less chance for the experimental group and the comparison group to interact as the classes for the groups were held on different times and often on different days. Besides, the majority (80%) of students were employed. The results indicated that the groups did not differ on their mathematics ability as measured by the TABE before or after the treatment although there was a significant improvement in the achievement level of all the students participated in the study. As both methods were theme centered instruction provided by experienced instructors, both methods may have worked equally well with the participants in the study. A limitation of the study was that as intact classes were used, students could not be randomly assigned to treatment groups. However, intact classes were randomly assigned to treatment groups.

Helping adults become and stay motivated to learn is often a complex task which requires planning. Motivation is a hypothetical construct with many conflicting theories regarding the direction of human energy. Motivation is also a dynamic process experienced by the adult learner as integrated levels of expectation, intent, and value within an emotional context. Three positive levels of motivation are: level one - expectation for success and a sense of volition; level two - level one and value; level three - level two and enjoyment. Motivation is a cause, a mediator, and an outcome of learning. As measured, motivation is a consistent positive correlate of academic achievement. Time on task and academic learning times are constantly influenced by motivation. Motivation's predicament is that it has a limited capacity in a world which competitively attracts its resources. Therefore, motivation tends to be extremely unstable in direction and magnitude. Adult motivations to learn are pragmatic, autonomous (suggestion and cooperation), conservative (age related), and participative (where expertise, experience, or situational factors make a difference). A core characteristic of a motivating instructor is enthusiasm.

There is a total of six motivational factors:

1. Attitude: A combination of concepts, information, and emotions that result in a predisposition to respond favorably or unfavorably

toward people, groups, ideas, events, or objects.

2. Need: A condition experienced by the individual as an internal force that leads the person to move in the direction of a goal.

3. Stimulation: Any change in perception or experience with the environment that makes a person active.

4. Affect: Emotional experience - the feelings, concerns, and passions - of the person.

5. Competence: The process and acquisition of effective interaction and mastery with the environment.

6. Reinforcement: Any event that maintains or increases the probability of the response it follows.

In the beginning of any lesson the attitudes of most adults and their felt needs for what are being learned are crucial influences on how they attempt to learn. During the learning process the stimulation involved in learning and the affective or emotional experiences of the adults are major influences upon their attention, interest and involvement. At the end of the learning process when the instructional objective is nearing accomplishment, the competence realized by the adults and the reinforcement value attached to successful learning influences the adults' motivation at that moment, and for the future as well, resulting in the formation of new attitudes and needs for what has been learned (Wlodkowski, 1996).

Recommendations for Further Study

This research has addressed the hypotheses, but at the same time has raised issues that require additional research. Some of these include:

1. Replicate the study to verify the findings. Include more colleges, different learning strategies, and different disciplines to achieve a broader sample that would be representative of the population of adult learners.
2. Expand the present study to include both urban and suburban colleges to determine if geographic region has an influence on pretest sensitization.
3. Investigate the effects of pretesting on students at other educational levels (secondary level) to determine if pretesting conditions students to achieve higher scores.
4. Examine the effects of cooperative education instructional strategies over a longer period of time, both cognitively through test scores and affectively by surveying the participants on their perceptions of the program.
5. Study the perceptions of college instructors on the use of cooperative education strategies in their classroom to produce better student outcomes.

APPENDIX A

Wayne State University
Multiple Project Assurance # M 1261
IRB B03

HUMAN INVESTIGATION COMMITTEE
Room 2238 Gordon H. Scott Hall
540 E. Canfield Avenue
Detroit, MI 48201
Phone: (313) 577-1628
FAX: (313) 577-1941

MEMORANDUM

TO: Thilak W. Gunasekera, Education
2277 W. Euclid
Detroit, Michigan 48206

FROM: Peter A. Lichtenberg, Ph.D. Peter A. Lichtenberg Ph.D.
Chairman, Behavioral Investigation Committee

SUBJECT: Exemption Status of Protocol # H 06-07-96(B03)-X; "Effects of Pretest Sensitization Associated with Cooperative Learning Strategies on the Achievement Level of Adult Mathematic Students"

SOURCE OF FUNDING: No Funding Requested

DATE: July 10, 1996

The research proposal named above has been reviewed and found to qualify for exemption according to paragraph #1 of the Rules and Regulations of the Department of Health and Human Services, CFR Part 46.101(b).

Since I have not evaluated this proposal for scientific merit except to weigh the risk to the human subjects in relation to potential benefits, this approval does not replace or serve in place of any departmental or other approvals which may be required.

This protocol will be subject to annual review by the BIC.

cc: S. Sawilowsky, 347 Education

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May 23, 1996

C. Seasock
Human and Animal Investigation Committee
Wayne State University
Detroit, Michigan 48202

Dear C. Seasock:

This letter serves as site confirmation for Thilak Gunasekera to conduct a study comparison of cooperative learning strategies as opposed to traditional teacher-centered instruction during the fall term 1996 at the Detroit College of Business.

Four groups of beginning math students will be selected for the study. Each group will have approximately 20 students. Mr. Gunasekera will be an instructor with the college during the fall term in order to complete his research for his paper entitled: "Effects of Pretest Sensitization with Cooperative Learning Strategies on the Achievement Level of Adult Mathematics Students".

Please feel free to contact me at (810) 558-8700, Ext. 301, if you have any further questions or comments about the project.

Sincerely,

Maryann Hartley-Dinger

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CONSENT FORM

Title: Effects of Pretest Sensitization Associated with Cooperative Learning Strategies on the Achievement Level of Adult Mathematics Students

Principal Investigator: Thilak Gunasekera

Introduction/Purpose: The purpose of this study is to find out how pretest affects achievement scores. This study is part of the requirements for a Doctor of Philosophy degree at Wayne State University.

Procedure: Four classes will be given a mathematics pretest at the beginning of the study. Eight classes will be given a posttest at the end of the study. The classes will be randomly assigned to the four groups. The study will begin on September 23, '96 and will end on October 29, '96.

Risks: None

Alternative Treatment / Procedures Any student who will be randomly selected to participate in the study, but who do not wish to take part for whatever reason, will be assigned to other parallel classes. Students may withdraw from the study at any time; or refuse to take the math pretest.

Benefits: It will be only of academic interest

Confidentiality: The names of participants in the study and all records will be kept confidential and be known only to the principal investigator.

<u>Title</u>: Effects of Pretest Sensitization Associated with Cooperative Learning Strategies on the Achievement Level of Adult Mathematics Students

<u>Questions:</u> If I have any questions concerning my participation in this study now or in the future, Mr. Thilak Gunasekera, and/or Ms. MaryAnn Hartley-Dinger, Director of the Resource Lab can be contacted at (313)895-8841 and (810)558-8700 ex 301 respectively. If I have any questions regarding my rights as a research subject, Dr. Peter A. Lichtenberg, Chairman of the Behavioral Investigation Committee can be contacted at (313)577-5174.

<u>Consent to Participate in Research Study:</u> I have read all the above information about this research study, including the experimental procedure, possible risks, and the likelihood of any benefits to me. The content and meaning of this information has been explained and is understood. All my questions has been answered. I hereby consent and voluntarily offer to follow the study requirements and take part in the study. I will receive a signed copy of this consent form.

______________________	______________________
Participant's signature	Principal Investigator's signature
______________	______________
Date	Date.

DEMOGRAPHIC / SUPPORT SERVICES AWARENESS QUESTIONNAIRE

DIRECTIONS: Please answer each question below.

1. Age: _____ 2. Sex: _____Male; _____Female

3. Marital Status: ____Married; ____Single; ____Divorced/Seperated

4. Number of Children: _____

5. Years between high school and first higher education class: _____

6. Years since last math class: _____

7. Are you employed? _____Yes; _____No

8. Number of hours worked: _____

9. I am enrolled in higher education because I (Check all that apply):

_____want a better job. _____ new career.

_____ prepare for a career. _____ self improvement

_____my boss wants me to get a degree.

_____other (please explain: ________________________________

____).

9. My college offers the following services:

SERVICE	YES	NO	UNKNOWN
Tutoring - Faculty	___	___	___
Tutoring - Peer	___	___	___
Computer Lab	___	___	___
Federal Pell Grant	___	___	___
College Work-Study Program	___	___	___
Federal Stafford Loan	___	___	___
Federal Plus Loan	___	___	___
Federal Supplemental Loan for Students	___	___	___
Scholarships	___	___	___
Veterans Benefits	___	___	___

APPENDIX B

Converting Number-Correct Scores to Grade Equivalents

Tables 19 through 30 and 47 through 58 contain number-correct score to grade equivalent norms for the individual tests and the total content areas in TABE 5 and 6. There is a table for each content area of the battery, by level and form. Number-correct scores for the first test in the content area are listed in the outer columns on either side of the table. Grade equivalents that correspond to the number-correct scores for the first test are listed in the column next to the number-correct scores. Number-correct scores for the second test are listed across the top of the table in the first row. Grade equivalents that correspond to the number-correct scores for the second test are listed in the second row of the table. The remaining numbers in the body of the table are the total content area grade equivalents that have been derived by averaging scale scores obtained on the two tests that constitute the content area. Table 77 contains number-correct score to grade equivalent norms for Spelling.

To obtain an examinee's grade equivalent for a total content area, find the examinee's number-correct score for the first test in the outer column of the table. Notice the row that this score falls in. Next find the number-correct score in the top row for the second test in the content area. Notice the column that this score falls in. Follow this column down until it intersects the row containing the examinee's score on the first test. The number in the box at the intersection is the grade equivalent for the content area.

A
6

TABLE 57
NUMBER-CORRECT SCORE TO SUBTEST AND TOTAL AREA GRADE EQUIVALENT
COMPLETE BATTERY, FORM 6
MATHEMATICS, LEVEL A

CONCEPTS & APPLICATIONS

No. Corr.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	No. Corr.
GE	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.4	5.1	6.0	6.1	6.6	6.9	7.2	7.6	7.9	8.2	8.4	GE
COMPUTATION [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

A
6

TABLE 57 (cont.)
NUMBER CORRECT SCORE TO SUBTEST AND TOTAL AREA GRADE EQUIVALENT
COMPLETE BATTERY, FORM 8
MATHEMATICS, LEVEL A

CONCEPTS & APPLICATIONS

No. Corr.	GE	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	GE	No. Corr.
		8.7	9.0	9.3	9.6	10.2	11.0	12.1	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9		
0	3.4	4.9	5.0	5.1	5.1	5.2	5.3	5.4	5.4	5.5	5.7	5.8	6.0	6.1	6.3	6.4	6.7	6.9	7.2	7.9	8.4	3.4	0
1	3.4	4.9	5.0	5.1	5.1	5.2	5.3	5.4	5.4	5.5	5.7	5.8	6.0	6.1	6.3	6.4	6.7	6.9	7.2	7.9	8.4	3.4	1
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9
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11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11
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20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20
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23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	24
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	32
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	34
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41
42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	42
43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43
44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44
45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45
46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	46
47	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47
48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48

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ABSTRACT

EFFECTS OF PRETEST SENSITIZATION ASSOCIATED WITH COOPERATIVE LEARNING STRATEGIES ON THE ACHIEVEMENT LEVEL OF ADULT MATHEMATICS STUDENTS

by

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The purpose of the study was to find out whether there was a significant pretest effect in the achievement level of adult students who were subjected to cooperative learning strategies as opposed to traditional teacher-centered instruction. Whereas pretest effects are well known and studied in psychology interventions for constructs such as personality, cognitive outcomes, and attitude outcomes, it is not known if pretest effects are prevalent in educational studies. Pretesting is more likely to be a threat when the time between pretesting and posttesting is short. If confounding due to the pretest can be ignored safely, then school districts can use them with cooperative learning strategies with greater confidence.

This study used the Solomon four-group design. It involved the random assignment of a sample of 169 students (88% female) with a mean age of 29.16 yrs. to one of four groups. Two of the groups were pretested and two were not; one pretested group and one unpretested group received instruction via cooperative learning strategies for five weeks. The remaining two groups received instruction via traditional methods also for

five weeks. All four groups were posttested and 121 students completed the study. Disregarding the pretests, Tests of Adult Basic Education (TABE) Form 6 Level A (having KR-20 reliability ranging from 0.71 to 0.94, with a median of 0.89 and a mode of 0.90) scores were treated with a simple 2 x 2 analysis of variance (ANOVA). As the main and interaction effects of pretesting were negligible, analysis of covariance (ANCOVA) was carried out, having pretest scores as the covariate.

The current study retained the null hypothesis that there was no significant pretest sensitization effect prevalent in educational variables. The study also retained the null hypothesis that there was no significant difference between the achievement level of students who received instruction via cooperative learning strategies and traditional methods. An alpha level of 0.05 was used for all statistical tests. The study supported the view that pretest effects are not prevalent in educational studies.

AUTOBIOGRAPHICAL STATEMENT

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