The Effect of Self-Monitoring Homework Processes and Teacher Assessments on Academic Achievement among Beginning Algebra Students

by

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Abstract

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One hundred and eighteen minority high school students in beginning algebra courses in a large, urban, inner city school participated in a study examining the effects of self-monitoring homework processes and homework outcomes on academic achievement. These two treatments were compared under process-oriented and outcome-oriented assessments in a 2 x 2 design with a separate control group receiving traditional curriculum instruction.

Students who self-monitored either processes or outcomes had significantly greater gain scores than the no self-monitoring control group. Self-monitors of homework processes significantly outperformed the self-monitors of homework outcomes. The self-monitors of processes who were given process assessments had significantly higher achievement than any other group except those students who self-monitored processes but were given outcome oriented assessments. Type of assessment was not related to gain scores.

Ad hoc analyses suggest that self-monitoring work at home yields higher achievement gains than self-monitoring homework in class while self-monitoring homework processes in class yields greater achievement gains than no self-monitoring. Educational implications and suggestions for future research examining homework completion, type of homework, type of assessments, self-processes, and replication of this study on different sample populations are discussed.

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Chapter 1

Introduction

This study examines possible remedies for the lack of achievement in mathematics among American children which has surfaced as an international, national, state, and local educational problem. Globally, the Third International Mathematics and Science Study (TIMSS, 1996) reported that the United States is lagging behind its major economic competitors in both math and science achievement. The United States placed twenty-third, slightly below average compared to the 40 other countries participating in the study. One of the lowest area of mathematics achievement was algebra (TIMSS, 1996).

In a state-by-state review of the National Assessment of Educational Progress (NAEP, 1996) data, Edwards (1996) reports, "There is no state in which at least half the students perform at the 'proficient' level or above. ... Every state still has at least 20% of its students who perform below 'basic level'. These students have not mastered even the fundamental skills and knowledge needed to do grade-level work." (p.26). As noted in the TIMSS report, the algebra areas of greatest concern in the NAEP (1996) were equation solving and verbal problems.

A closer look at local districts reveals that minorities in poor, urban areas performed lower than their suburban, Anglo-American, or Asian classmates. Fewer than 10% of the African-American and Hispanic students in the fourth and eighth grades were proficient in math. They scored at least 25 points lower than Anglo-American students. Only 37% of African-American, Hispanic, or American Indian children enrolled in math classes beyond basic algebra, which suggests why only 28% of low income children were enrolled in college preparatory tracks (Edwards, 1996).

These findings suggest that some changes need to be made to improve mathematics achievement in all schools, especially achievement of poor, urban, minority populations. What is particularly alarming about these poor results is that improvement in mathematical academic achievement has been a major focus of educational reform for the past fifty years.

This introductory chapter will examine prior educational reform efforts. An alternative, more student centered, instructional model designed to enhance self-regulation of mathematical academic achievement will then be presented. Finally, existing structural and procedural administrative practices which might hinder the implementation of student self-regulatory practices will be discussed.

Prior Educational Reform Efforts

Most educational reforms to improve academic achievement focused on changing behaviors of teachers and administrators, not students. Historically, Zimmerman (1989) notes that after World War II, instruction in American schools was influenced by Thurston's (1938) mental abilities model. His Primary Mental Abilities Test provided a description of student abilities and administrators or teachers then classified and placed students in the educational setting which best suited them. Teachers taught their curriculum to the ability level of each group of students. Cronbach (1957) introduced an Aptitude by instructional Treatment Interaction (ATI) statistical procedure to analyze the effectiveness of this student/educational process match. However, research on matching instructional procedures to student ability groups using Cronbach's ATI analyses has been disappointing (Bracht, 1970).

Zimmerman (1989) reports that the successful orbiting of the Soviet Sputnik in 1957 created an educational crises. Performance of American mathematics and science students was considered inferior to Soviet youth so federal funding was appropriated to close the gap. The War on Poverty, Project Head Start and Followthrough, and the National Defense and Education Act of 1964 which created Title I to Title VII funding were born. These programs of the early 1960's were based on Bloom's taxonomy, and Hunt's writings on the importance of early experiences on children' intellectual development (Zimmerman, 1989) .

Educators in this period focused on remediating the disadvantages in the intellectual environment of the homes of poor children through improved experiences in school. Given Rosenberg's (1965) evidence of lower self-esteem by lower-class children, Holt (1964),and Glasser (1969) proposed school reforms such as less reliance on grading for promotion, more flexible curricular requirements, more guidance counselors to help with student's social adjustment, and more efforts to involve parents and families of students in the schools. The goal of these recommendations was to make school more relevant and less threatening to these lower class students.

During the mid-1970's, declining measures of national achievement on standardized tests lead to a reassessment of the educational policies implemented during the 1960's (Zimmerman, 1989). The decline in student achievement was attributed to a decrease in the number of courses required to graduate, reduction of the number of advanced courses offered in high school, lack of standardized testing, and less stringent testing for promotion, graduation, and teacher certification. A call for "back to basics" and "standards" was heard throughout the educational community.

Several national boards were commissioned to evaluate the quality of instruction in the United States. The Carnegie Foundation and the Secretary of Education published Nation at Risk (National Commission on Excellence in

Education, 1983) which criticized teacher quality, curriculum requirements, and achievement standards. A "back to basics" curriculum which increased the number of math, science, and English courses was created. The time-on-task learning model emerged based on the assumption that "all students can learn", but some take longer than others. Students who have failed a subject were asked to repeat the material, to allocate more time to study, or to complete more homework.

Later time-on-task models such as Slavin's (1987a) QAIT (Quality of teaching, Accurate placement, Incentives, Time on task) program examine the quality of teaching, motivational issues, and student's prior knowledge. However, the material which the student failed to learn was simply retaught using the same style, sequence, and methodology. Instead of creating learners, the time-on-task model created "repeaters." Students who failed beginning algebra four times, became frustrated, and then dropped out (Harvey, 1996).

A type of mental ability model resurfaced in the back to basics reform movements. The individual difference model used IQ tests, placement tests, or anecdotal behavior reports to place students in different academic tracks. "Tracking" also created the need for Special Education. A separate department of the school to serve students who were learning disabled, physically or emotionally handicapped, or behaviorally difficult (Becharis, 1996).

The NAEP (1988, 1996) data and the TIMSS (1996) report cited earlier suggest that these reform models failed to increase student achievement. In addition, more stringent course standards increased the drop out rate, increased the costs of hiring qualified teachers, and diminished the vertical mobility of students whose language and culture were different from the dominant middle class culture (Shanker, 1988).

In addition, none of these educational reforms explained exceptions to group performance. If low social/economic status is a predictor of failure, why were there examples of academic success among minorities in the poorest inner-city neighborhoods (Wibrowski, 1992). If culture was a barrier to success, why did some recent immigrant refugee children perform well (Calpan, Choy, & Whitmore; 1992)? If mental ability was the best predictor of academic success, why did students who have superior mental ability, superior environmental conditions, and unlimited access to superior educational standards achieve poorly?

All the learning models used to justify school reforms instituted in the past fifty years rely heavily on the teacher or administrator to evaluate and change student's academic achievement. Although the curriculum, the school environment, teacher training, and teacher behaviors may have changed, the responsibility for education was always given exclusively to the teacher or administrator. Relatively little attention has been given to the student's role in the learning process.

Previous reform models viewed students as passive receivers of educational information and policies. Students were not responsible for initiating or substantially supplementing learning experiences designed to educate them. They did not assist in discovering which tasks were unlearned by them or in modifying learning techniques to change outcomes. A learning model which assumes that students play a more significant role in their learning may be more successful in increasing academic achievement.

Self-Regulated Learning Model

A self-regulatory model assigns the responsibility for learning more squarely on the student. Zimmerman (1994) describe self-regulated learning as "the degree that individuals are metacognitively, motivationally, and behaviorally active participants in their own learning process" (p. 3). This model helps the individual students acquire skills which allow them to self-monitor, self-evaluate, self-react, and correct their learning procedure. They then "can improve their ability to learn through selective use of metacognitive and motivational strategies, proactively select, structure and even create advantageous learning environments; and can play a significant role in choosing the form and amount of instruction they need" (Zimmerman, 1989, p.1). Zimmerman's (1994) self-regulatory model creates a rubric to describe successful academic self-regulation. The subject must successfully answer "why?", "how?", "what?", and "where?" questions regarding the psychological dimensions of the task and motivation, the personal self-regulatory attributes, and environmental self-regulatory processes.

The psychological dimensions related to the task are motivation (why do we want to self-regulate this task?), choice of procedure to self-regulate (how do we self-regulate this task?), the standards by which the subject judges success (what is our standard of successful self-regulation), and how the subject controls the environment (where does the subject self-regulate?).

Zimmerman's (1994) rubric lists questions regarding personal self-regulatory attributes such as: Whether the subject is intrinsically or extrinsically motivated? Is the strategy planned or automatized? Is the subject aware of the outcomes? Is the subject aware of the environmental influences on him or her?

The self-regulatory processes affecting motivation in this self-regulatory model are self-goals, self-efficacy beliefs, values, and attributions. Zimmerman (1994) applies his why, what, how, and where questions to motivation. We ask: Why do I want these goals? What is my goal? How can I achieve these goals? Where can I get help to achieve these goals?

Finally, self-regulatory processes to control the environment are environmental structuring, help-seeking, removing negative influences, or choosing positive role models (Zimmerman, 1994). Examples of questions to be answered by the self-regulator are: What distracts me? Why is that a distraction? How can I stop or ignore the distraction? Where does this distraction occur?

Enhancing Academic Self-Regulation

Research has shown that self-regulatory processes have increased mathematical achievement (Pintrich & DeGroot, 1990), computational skills (Schunk, 1981), reading comprehension (Schunk & Rice, 1984; Borkowsky, et al, 1990), and writing (Bandura & Zimmerman, 1994). Self-regulatory processes which increase attention span (Morrow, Burke, & Buel, 1985; Christie, Hill, & Lazanoff, 1984) and time on task (Gettinger, 1984) which have been shown to improve academic achievement.

There have been attempts to infuse this self-regulatory model into the classroom, such as that by Zimmerman, Bonner, & Kovach (1996). These researchers use completion of homework as tasks to teach students self-regulated studying. Through close monitoring of personal study methods and their outcomes, students begin to experience a sense of efficacy about their academic futures.

Another area of self-regulatory processes is strategy use. Using strategies has been shown to improve academic achievement in solving verbal problems

(Montague & Applegate, 1993; Seike, et al, 1991; Davis-Dorsey, et al, 1991; Fuson & Willis, 1989; Jitendra, et al, 1996; Bassler, Beers, & Richardson, 1985); using signed numbers (Pysher, 1996); problem solving (Paris, Newman, & Jacobs, 1995; Swing, Stoiber, & Peterson, 1988), and computational skills (Schunk, 1981; Carpenter, T. P., Moser, J. P. & Romberg. T. A., 1982). Strategy use has also been shown to improve students' motivation constructs which lead to improved academic achievement. It has reduced time needed on task (Gettinger, 1989), improved self-esteem, self-efficacy, goal setting, self-worth (Hattie, 1996), positively affected motivational beliefs included attributions, and self-efficacy (MacLeod, Butler, & Syer, 1996). These positive results are particularly noteworthy since learning-disabled students were used in the samples studied in most of this research. If gains were achieved in populations who have difficulty processing, storing, and retrieving information, their potential for mainstream populations would be even higher.

Historically, teachers of mathematics have used a form of strategy learning, otherwise known as algorithms. Finding common denominators, inverting to divide fractions, using the "money game" to add signed numbers, "same sign/add, different sign/subtract", "two negatives make a positive", identifying the coefficients in the equation of a line in the point-slope method of graphing, "I am thinking of a number" to factor, SOHCAHTOA, or any other algorithm or mnemonic device could be considered a mathematical strategy. Why is strategy use ineffective in a classroom, as cited in the NAEP (1996) data, when it has produced positive results in the literature?

Clearly, any strategy cannot be successful unless it is used effectively. Teachers may not ask strategy use questions in their assessments and this may lead to discontinued use. If the student was a passive receiver of the strategy treatment, they may not have been made aware that their successful learning was attributable to strategy use. Since they may not be aware of its effectiveness, students may not be motivated to apply the strategies when working without a teacher (Borkowski, Carr, Rellinger, & Pressley; 1990). Strategy use does not become fully self-regulatory unless students can self-monitor their use of the strategy, see its effectiveness, and attribute that success to strategy use. Only then will students continue to use a strategy.

How is self-monitoring operationalized and taught?

Zimmerman and Paulson (1994) describe academic self-monitoring as the students' efforts to self-observe and evaluate information about specific personal processes or actions that affect learning and achievement in school. From this information, students can self-evaluate their progress and make necessary changes to insure goal attainment. Self-monitoring plays a central role in the self-regulatory model proposed by Zimmerman (1994). Self-monitoring is closely linked to self-evaluation, self-reaction, and a feedback loop.

Self-monitoring can serve as a tool for self-improvement by enabling students to direct their attention, to set and adjust their goals, and to guide their course of learning more effectively. Self-evaluations are comparisons of self-observation with a goal or performance standard. Self-reactions are personal satisfaction and the course of action chosen by the subject after evaluating this information. The feedback phase describes the external or internal evaluation of the self-reaction and original goal. The entire self-regulatory cycle then repeats: goal directed action is self-monitored and self-evaluated, self-reaction creates a behavior to change outcomes, and feedback is obtained to judge the accomplishing of the goal and the success of the process.

Of the four processes in self-regulation, self-monitoring is most important for three reasons. It is the first in a sequential dependent process and, as such, it greatly determines the course of succeeding processes. For example, students who monitor learning processes instead of outcomes will have different self-evaluative standards, and have different self-reactions (Zimmerman & Kitsantis, 1997). Students who self-monitor the completion of algorithmic steps will have more proximal goals and different reaction choices which should help them reach the outcome more positively than students who try to get the best paper in class.

A second reason for focusing on the self-monitoring phase of self-regulation is that teachers greatly control the amount of self-evaluation, self-reaction and feedback (Richards, 1996). Students are presented with a day-to-day evaluation of their performance through teacher comments. Teachers then suggest reactive behavior to change or continue these student performances. Feedback is provided by the teacher in the form of grades. Student's self-evaluations, reactions, and feedback are not encouraged. They may possibly conflict with those of the teacher.

A third important reason to focus on self-monitoring is that it is the phase of self-regulation which can most easily be taught in schools. Self-monitoring skills can be taught through record keeping, creating diaries, keeping journals, and writing reports. These tasks are included in many English and Social Studies curriculum. Zimmerman's (1996) multidimensional model of when, where and how of self-regulation occurs can be easily answered by the student if they self-monitor their academic functioning.

Self-monitoring strategy process and outcomes

Recent research suggests that monitoring the process of achieving the goal is more productive than monitoring the outcome. Lan, Bradley, and Parr (1994) found that students who monitored the time and amount of homework completed performed better than students who monitored their grades. These researchers suggest that students who self-monitored the process of homework completion were forced to implement the procedures discussed in class more thoroughly than students who just recorded the number of problems answered correctly.

Schunk and Swartz, (1993) found that students who focused on following a strategy to create a good paragraph wrote longer, better quality essays than those students who were told to "do their best". These researchers contend that a more proximal goal was presented by process self-monitoring of strategy use.

Zimmerman and Kitsantas (1996, 1997) found that girls who focused on the process of throwing a dart outperformed those who focused on the target. These researchers suggest that process evaluations changed self-judgments while the subjects self-monitored. This feedback created different cognitive and connotive adjustments by the student. Pysher (1996) concluded that process self-monitoring of strategy allowed his students to more efficiently retrieve the correct use of the strategy for addition and subtraction of signed numbers.

Zimmerman and Kitsantis (1997) reported evidence that attributions of outcomes to strategy use increased task skill, self-efficacy beliefs, and intrinsic interests in the task. These appear to be some of the most favorable attributions reported to date. The positive effect of process versus outcome goal setting is noted by Nicholls (1984). Students having an ego involvement orientation had lower self-efficacy and performance than those having a task involvement orientation. Similarly, Hayes and Page (1979) suggest that students who have internal locus of control feel they can affect their learning process. These students attribute academic failures and successes to themselves and believe they can affect the process of solving these problems. Poorer performing students attribute outcomes to "luck" so they do not believe that any self-process will lead to accomplishing their goals. They accept outcomes as fixed and unchangeable.

Can self-monitoring homework processes be accomplished in the school environment?

Self-monitoring of process may be problematic given the existing school environment. Outcome oriented assessments necessary for graduation and admission to college become more important in high school. Students will be judged by their final exams, Regent's tests, and Scholastic Aptitude Test (SAT) scores. Teachers are held responsible for students achieving high scores on these outcome oriented, standardized tests. Preparing students for these tests affects teacher's lesson plans and administrator's curricula. Teacher's classroom assessments reflect an outcome orientation which may force students to value outcome rather than process goals. Will teacher's high valuation of these outcome goals affect the quality and quantity the student's use of process self-monitoring? Will process oriented homework conflict with outcome oriented assessment vehicles traditionally used by teachers?

Conclusion

Recent surveys (NAEP, 1996; TIMSS, 1996) examining achievement in mathematics by American students have suggested that changes in educational practices are necessary, especially in schools serving poor, urban, and minority populations. For over fifty years, educational administrators have attempted to use mental difference models, environmental differences models, and back to basics models to improve mathematical academic achievement. Each of these models places the emphasis on factors over which students have little control. Zimmerman's (1994) self-regulatory model is suggested as a student initiated alternative to increase academic achievement.

Zimmerman, Bonner, and Kovach (1996) suggest strategy learning and homework completion as tasks to implement self-regulation in the classroom. Strategy learning has proven to be successful in increasing academic achievement in many difficult mathematical task areas. However, students often do not continue using strategies without teacher supervision. Self-monitoring leads students to attribute their successful solutions to strategy use. Process self-monitoring has been shown to increase achievement more than outcome self-monitoring. However, the widespread use of outcome oriented assessments by teachers and administrators may conflict with self-monitoring of student processes by students.

This research compares the effect of self-monitoring homework processes and homework outcomes on mathematical academic achievement among beginning algebra students under both outcome and process oriented assessment conditions.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to outline the research on five related constructs: strategy learning, self-regulation, self-monitoring, self-monitoring of process, and teacher assessments. The literature on strategy learning to increase achievement in mathematics and specifically in the task areas of solving algebraic and verbal problems will be reviewed first.

Strategy use

Of the 33 articles on strategy learning in mathematics published between 1987 and 1997 and listed in Psychological Abstracts, there were 17 studies of middle and high school students.

Cognitive benefits of strategy use. Strategy use has been shown to improve academic achievement in difficult mathematical task areas such as solving verbal problems, solving equations, operations with signed numbers, and using computational algorithms. Successful strategies to solve verbal problems include generating tables, rewording, personalizing situations, classifying problem types, using question protocols, and translating key words directly from English to mathematical symbols.

Seilke, Behr, and Voelker (1991) improved seventh grader's ability to write equations for word problems by having them generate tables using various real numbers to generate several examples expressing the relationship dictated by the verbal problems. They then could express the same relationship using an unknown. Davis-Dorsey, et al (1991) used rewording and personalization of context as a strategy to produce more solutions to mathematical word problems. Since the personalization strategy was more effective with fifth graders than second graders, these researchers suggest that older children have more schema to draw on, which made problems more motivating and easier to mentally represent.

Fuson and Willis (1989) improved elementary school student's ability to solve word problems by having them draw schematics to represent the different classes of problems (compare, add on, difference, etc.). These drawings also made the students more aware of object/referent switches or "inconsistent" word problems. This type of verbal problem fails to create a direct translation of key words from verbal to mathematical expressions. A direct key word translation of "10 more than a number is 12" is $10 + x = 12$. In this example, "more than" directly translates to "+", and "a number" directly translates to "x", and "is" directly translates to "=". However, a direct translation of "8 less than a number is 15" would be "$8 - x = 15$". The correct equation for this verbal expression is "$x - 8 = 15$". Key word strategies are problematic when the operation is subtraction. Jitendra, et al (1996) replicated Fuson's categorizing strategy to improve verbal problem solutions for elementary age students with mild disabilities.

Bassler, Beers, and Richardson (1985) taught two strategies to their middle school sample. They used Polya's (1973) four step problem solving technique (clarifying, restating, decomposing, and correcting errors) and the key word technique described above to solve verbal math problems. Their subjects improved mathematical ability significantly with either method with no significant difference between treatment effects.

Swing, Stoiber, and Peterson (1988) also tested multiple strategy use. They taught a variety of mathematical problem solving strategies to one elementary school group while the control group used a single algorithm repeatedly for an amount of time equal to that necessary to learn the various strategies. They showed that multiple strategy training increased mathematics achievement more than an intensive algorithm approach. Even with increased practice, non-strategy users did not perform as well. These researchers suggest that classroom time is better spent learning to use strategies rather than on "drill and kill" repetition of algorithms. Strategy use has also been shown to reduce time needed on task. Gettinger (1989) taught strategies and used poker chips as incentives to decrease the time needed to learn computational tasks. The strategy use increased productivity and retention and the incentives increased motivation in this learning-disabled, high school sample.

Pysher (1996) showed positive effects of strategy use in another difficult mathematical task area, equation solving, using a sample of at-risk high school students. He used a three question protocol for solving one and two step equations: "What is the operation?", "What is the inverse operation?", and "What is the result when we perform that operation to both sides of the equation?". Strategy users significantly outperformed non-strategy users.

The process of how strategies enable students to store and access information is explained by Chi, Glaser, and Farr's (1988) research comparing expert chess players with novices. Experts develop strategies for chunking together large quantities of information, storing these chunks, identifying cues to easily access them, developing strategies to remember the cues, and checking their work. Once the strategy is activated, the goal is reached by sequentially following the steps to implement the strategy.

Connotive benefits of strategy use. Strategy use has improved students' self-worth, self-esteem, self-efficacy, intrinsic motivation, interest, and goal setting in domains other than mathematics. Hattie's (1996) research into career choice suggested that the increased success caused by strategy use changed self-images and self-worth estimates. Enhanced self-perceptions created the potential for the subjects to see themselves as successful in new and different job situations. This increased self-esteem increased the number of career choices in which these subjects felt they could be successful. Improvement in self-efficacy perceptions have also been shown to mediate improvement in academic achievement (Zimmerman, 1989; Schunk & Swartz, 1993; Schunk, 1981).

Strategy use has been shown to increase student's intrinsic motivation. Zimmerman and Kitsantis (1996, 1997) found that using a process self-monitoring strategy increased the intrinsic motivation of their female high school sample towards dart throwing. Olshavsky (1976) taught a middle school sample four different reading comprehension strategies: guessing from context clues, a phonics approach, predicting the ending, and skimming the text followed by rereading. He found that no matter which strategy was used, both student interest as measured by time on task and student reading skill as measured by reading comprehension tests were improved.

There may be some transfer effects of strategy use across domains. Kamann and Butler (1996) developed a Strategic Content Learning curriculum which covered many domains. Teacher interactions and student achievement gains were measured in math, reading, science, and social studies using a post-secondary learning disabled sample. These researchers found that a curriculum-wide use of strategy learning increased the occurrence of student's use of a strategy in a domain other than the one in which it was originally taught. Students who experienced strategy use across domains invented their own strategies more frequently instead of simply duplicating those given by the teacher. Academic achievement improved in all domains. Case study evidence (MacLeod, Butler, and Syer, 1996) revealed benefits of strategy learning beyond increased academic achievement. For example, strategy use increased student's motivational beliefs, attribution, self-efficacy, epistemological beliefs, knowledge about themselves, and metacognitive processes as well as increasing strategy, domain, and task knowledge

This literature raises some interesting questions. If strategy learning is so productive, why don't teachers of mathematics teach it more often? The National Council of the Teachers of Mathematics (1991) suggest that most teachers do teach strategy use. Every procedural algorithm or any mnemonic device which teachers use to help students remember that algorithm can be called a strategy. For example, "same sign, add; different sign, subtract" when combining signed numbers, starting with the highest place value in the divisor when using the division algorithm, finding common denominators, graphing by the slope-intercept method, "two negatives make a positive", and lining up decimal points when adding or subtracting are commonly taught strategies. Student implementation of those strategies, however, often proves to be difficult.

Strategies are not implemented equally by all students. Montague and Applegate (1993) compared math achievement, math reasoning, mathematical word problem solving ability, and strategy knowledge use among learning-disabled, mainstream, and gifted middle school children. Their research showed that learning disabled children learned and used strategies taught to them by their teachers much less often than mainstream or gifted children. Gifted children created their own strategies more often than mainstream children.

Paris, Newman, and Jacobs (1985) suggest three criteria necessary for continued strategy use: (a) students must believe that the strategy will work; (b) students must believe that the amount of time and effort needed to use the strategy is worth the successful results gained from strategy use; and (c) students must be able to use it with minimal effort with minimal time taken away from other activities. If these three criteria are not met, even the best strategy will not be used.

Knowing a strategy is not enough to guarantee its effective use. Students may overestimate their understanding of how and when to use a strategy (Ghatala, Levin, Presley, & Goodwin; 1986). Students may not feel confident using the strategy (Schunk & Hanson; 1985). Students may not attribute their successful learning to strategy use and therefore not choose to use it when working alone (Pressley, Borkowski, & Schneider; 1987). Teachers report that students often are not aware that they are using a strategy even when using it successfully (Maslow, 1995). In addition, research such as Bassler, et al (1985), Swing, et al (1988), and Olshavsky (1976) showed improvement in cognitive and connotive variables using multiple strategies. These findings suggest that the type of strategy may not be as important as some underlying construct which may be activated while using a strategy. That construct may be self-regulation.

Self-regulation literature

A review of the literature on self-regulatory practices shows that they have been successful in the school environment. As a intervention, self-regulation has directly increased academic achievement when it involves use of study techniques and indirectly increased academic motivation by promoting positive connotive changes. Self-regulatory methods have been used to increase student time on task and focus attention.

Zimmerman and Martinez-Pons (1992) showed that the use of self-regulatory practices improved achievement, motivation, and persistence at all age levels in many disciplines. In the domain of mathematics specifically, self-regulation has been shown to improve computational skills in fourth graders (Schunk, 1981), operations with signed number in high school students (Pysher, 1996), and academic achievement in mathematics in college age students (Pintrich & Degroot, 1990; Lan, Bradley, & Parr; 1994). Self-regulatory interventions have been shown to have an indirect effect on increased academic achievement in mathematics by increasing intrinsic motivation and self-efficacy ratings (Schunk, 1981) as well as reducing mathematical test anxiety (Pintrich & DeGroot, 1990). Gettinger (1984) reduced time needed to learn a task and increased persistence on task by implementing self-regulatory strategy use.

School psychologists have used self-regulation training to modify the behavior of poor performing and disruptive students. Morrow, Burke, and Buel (1985) have used diary and journal writing followed by student created plans of action to change students' behaviors. This written form of self-monitoring increased academic achievement in learning disabled, high school students. Christie, Hill and Lazanoff (1984) improved student's study habits, time on task, and attention by diary keeping and playing a "concentration thief" game. Students self-monitored by asking themselves "what is stealing my concentration" at periodic intervals in class then refocused on the assigned task. Skinner and Smith (1992) reported that self-management (their term for self-regulation) can be taught to even the most disruptive students. They recommend training students to self-observe, record, evaluate, correct, and prompt their own behaviors. They suggest that school psychologists and teachers should structure classroom ecology to promote these self-regulatory processes.

However, no behavioral modification strategies will be successful if teachers will not implement them. Martens, Peterson, Witt, and Cirone (1986) conducted teacher acceptability research with regard to mandated behavioral programs. They found that teachers prefer student-managed intervention such as diaries for self-monitoring because they can be implemented in the classroom without massive amounts of teacher time to maintain them. They point out that this simplicity of implementation will become even more important to educators as they are being asked to handle more discipline problems caused by mainstreaming and increasing class-size.

In addition to these teacher-directed, purposeful interventions into the classroom, self-regulatory skills are used in the schools by successful students. Zimmerman and Martinez-Pons (1986) surveyed successful high school students concerning study habits. They report these high-achieving students listed 14 self-regulatory processes, among which were organizing and transforming information by rewriting and rereading; monitoring and evaluating progress by reviewing notes, tests, textbooks, and studying missed problems on tests; keeping records of progress and time management by using schedules; and help-seeking when studying.

Pressley, Borkowski, and Schneider (1987) analyzed successful students using the Good Strategy User (GSU) model. These researchers contend that successful students use a variety of strategies; knows when, how, and where, to apply the strategies; understands that good performance is linked to effort in carrying out the strategy; and has non-strategic knowledge about the world in general. These four qualities mirror Zimmerman's (1994) psychological dimensions of task, motivation, personal attributes, and environmental concerns which produce self-regulatory behavior.

Since positive self-regulatory behaviors show increased academic achievement, why not teach these skills to unsuccessful students? Attempts have been made to infuse self-regulatory skills into the academic curriculum. Zimmerman, Bonner, and Kovach (1996) published "Developing Self-Regulated Learners: Beyond achievement to self-efficacy", a textbook designed to teach self-regulatory behavior to middle school students. They provide strategies, homework, and class work to improve time planning and management skills, reading comprehension and summarization skills, note-taking skills, test anticipation and preparation skills, and writing skills.

These researchers propose a cyclic model of self-regulation: Self-Evaluation and Monitoring, Goal Setting and Strategic Planning, Strategy Implementation and Monitoring, and Strategic Outcome Monitoring which leads back to Self-Evaluation and Monitoring. The cycle is repeated until the student feels successful. Students are expected to participate in goal setting, evaluation, and strategy choice.

Since the traditional structure of school often limits student self-regulation, Zimmerman, Bonner, and Kovach (1996) propose that schools model themselves after a learning academy or "Schools organized as learning academies around disciplines such as music, dance, art, military regimen, or science (which) ... focus on developing improved methods of performance as well as imparting established knowledge. We believe that key aspects of this educational model can be introduced by teachers during homework activities" (p. 8).

They then suggest how homework can be self-monitored. "The teacher distributes forms for students to monitor aspects of their studying....The teacher shifts the focus from merely assessing the accuracy of students' homework to identifying their processes of studying by having them exchange work with their peers. After a class discussion of optimal learning strategies and outcomes, the peers will evaluate the homework and self-monitoring forms and make suggestions regarding how the students can improve their methods of studying. Finally, teachers will then collect the homework for grading purposes and to review peers' suggestions" (p 18-19).

Zimmerman, Bonner, and Kovach (1996) focus on self-monitoring because it is the initial process upon which the other three depend. Also, the operationalizing of self-monitoring consists of record keeping in journals or diaries which has already been successfully taught in the school environment.

Self-Monitoring Literature

Research into self-monitoring of mathematical tasks is sparse. However, Maag, Reid, and DiGangi (1993) provide a literature review of self-monitoring research across all domains including mathematics. They divided these 20 studies into those monitoring attention and those monitoring academic output. Their meta-analysis showed increases in on-task behavior for each self-monitored task in every domain.

These researchers then conducted an experiment in which they taught three conditions of self-monitoring: attention, academic output, and academic accuracy, to a group of special education high school students. Attention was monitored by recording what task the student was focused on when a bell rang. Output was monitored by recording the number of problems finished over a number of trials. Accuracy was defined as the number of problems correctly answered over a number of trials. There was no feedback or corrections of monitoring. Students were assigned conditions randomly and performed in each condition in a repeated measure format. Outcome measures included student time on task, number of problems completed, and number of problems correct. Maag, Reid, and DiGangi's (1993) results showed that students improved performance in each of the three areas that they self-monitored.

Delclos and Harrington (1991) taught fifth and sixth grade children to play a problem solving computer game. The group which received both problem solving training and self-monitoring outperformed both the problem solving alone and the control group. Their monitoring vehicle in this experiment was self-questioning based on Polya's (1973) problem solving strategies of clarifying, restating, decomposing the problem into smaller parts, and correcting errors in the computer program. This self-monitoring vehicle monitored the quantity of these behaviors on a tally sheet. These researchers then suggested self-evaluative and self-reactive strategies to the students.

Lan, Bradley, and Parr (1994) asked their graduate students to monitor their statistics homework. Their self-monitoring protocol was a diary in which time required to compete homework and tutoring time was recorded. Another group kept a diary of class lecture time, tests, and class discussion. Both vehicles included a self-efficacy estimate of how confident each student felt they could complete problems taught that day in class. The students were asked to record their responses every time they studied for the statistics course. The instructor reviewed the protocols at each class session by checking for completion of the vehicle. Number correct and number attempted was not recorded. The homework self-monitoring group showed significantly improved course grades when compared to those who monitored classroom activity.

Self-monitoring vehicles are relatively simple to create. Both Lan, Bradley, and Parr's (1994) and Zimmerman, Bonner, and Kovach's (1996) homework monitoring vehicles ask subjects to quantitatively list the assignment, date, time started, time spent, where homework was completed, with whom homework was completed, and distractions. Both vehicles contained a self-efficacy rating. Zimmerman, Bonner, and Kovach (1996) also assessed self-processes by examining notes taken by students during their self-regulatory training.

Weinstein, Schulte, and Palmer (1987) assessed students' thoughts, attitudes, beliefs, and behaviors that relate to academic success in their "Learning and Study Strategies Inventory" (LASSI). This 77-item diagnostic/prescriptive self-report also measures strategy use and goal setting. A similar self-regulatory inventory was developed by Lindner (1996). It asks 60 questions regarding strategy use, goals, behaviors, self-efficacy, use of study time, and motivation. However, Weinstein, et al (1987) and Lindner (1996) are one-time assessments which assess global attitudes towards constructs such as self-efficacy, goal setting, strategy use, and motivation based on previous outcomes. Delclos and Harrington (1991), Lan, Bradley, and Parr (1994), and Zimmerman, Bonner, and Kovach (1996) monitored self-processes during the completion of a specific task.

Process self-monitoring literature

Process self-monitoring has been shown to be more successful in increasing achievement than outcome monitoring in such diverse domain areas as mathematics, writing, and motor skills. Each of these studies created a strategy and asked the subjects to monitor a part of the process rather than focusing on the outcome.

Pysher (1996) used a strategy for solving signed number problems which asked his high school subjects to follow a question asking procedure of "What is the operation?", "What is the procedure?", and "What is the new equation?" using a flowchart. This self-monitoring vehicle was designed to focus them on the process of implementing the strategy. The control group was asked to monitor the number of correct answers only. The process oriented self-monitoring group outperformed the outcome oriented control group. This group's self-efficacy was also increased. Schunk (1981) showed that fourth graders who focused on the process of using a strategy during addition/subtraction tasks were more successful than those who focused on getting the correct answer. He also reported greater increases in self-efficacy for the process monitoring group.

Schunk and Swartz (1993) showed that monitoring the process of writing produced better results than monitoring the product. They asked middle school students to write paragraphs with the instructions "follow the steps to get a good paragraph" and then asked them to monitor how well they were following the steps. The control group was asked to "try to do your best." The process self-monitoring group produced more paragraphs which had better structure and content than did the control group. These researchers explain their results in terms of Bandura's (1986) social learning theory. "Follow the steps" creates a more specific, proximal goal for the subject than does "Do your best:"

Zimmerman and Kitsantas (1996) showed that process rather than outcome self-monitoring improved motor skills. Their high school sample was taught dart throwing. Some students were told to monitor the position that their hand was in when they released a dart. Others were told to concentrate on where the dart landed on the target. Those who self-monitored the process of throwing scored higher than those who monitored outcome. In addition, a subset of each group was asked to write about their experiences in a self-report vehicle. These self-judgments as to how well they were dart throwing improved the scores in each self-monitoring condition.

An intrinsic motivation measure was included in a pre and posttest. Subjects were asked to rank a list of physical activities including dart throwing from most favorite to least favorite. Students who used process self-monitoring showed a higher ranking for intrinsic motivation to throw darts in their posttests than in their pretest.

Zimmerman and Kitsantas's (1997) expanded their 1996 research to examine the possibility of developmental stages in self-monitoring. They added two new groups to a replication of their dart throwing experiment. A "shifting goal" group (process to outcome orientation) began initially using process goals and then changed to outcome goals when the dart-throwing strategy was automatized. A "transformed" group (outcome to process orientation) was taught to self-react to outcome information by making strategic process adjustments. The transformed goal group out-performed the group which focused on outcome only but did not surpass the shifting goal group. The shifting goal group which had automatized the process and switched to an outcome motivation outperformed the process self-monitoring groups.

Not only was the dart-throwing score of the shifting goal group higher than the process monitoring groups, but self-efficacy, intrinsic interest, self-reactions, and attribution to strategy ratings were higher. Zimmerman and Kitsantas (1997) concluded that a developmental shift from process goals to outcome goals is beneficial when the process has been automatized. Moreover, strategy attributions made by all process self-monitoring subjects preserved self-efficacy beliefs much longer than the ability or effort attributions made by the outcome self-monitoring groups. As in their earlier study, these researchers subdivided each of their dart throwing samples into self-reporters and non-self reporters. Those subjects who contemporaneously recorded their results outperformed non-recorders in each group.

Zimmerman and Kitsantas (1997) demonstrated that self-regulated strategy process goals influence the types of attributions that students make. Zimmerman and Martinez-Pons (1992) hypothesized that strategy attributions will preserve self-efficacy beliefs much longer than ability or effort attributions. Failure attributions to poor strategy implementations or choice will sustain hope until the learner's strategic repertoire is exhausted (Anderson & Jennings,1980; Clifford, 1986; Zimmerman & Martinez-Pons, 1992). Self-efficacy and intrinsic motivation increases may result from the self-monitoring of a process which succeeds. Besides providing positive feedback, the subject knows how to recreate the success and knows that he or she is in control of that success.

Zimmerman and Kitsantas (1997) cite Zimmerman and Bonner's (1997) four phases of students' development of complex cognitive-motor skills as a model of their dart throwing treatment. Subjects followed a four phase sequential model of observation, imitation, self control, and self-regulation. Students watched how the instructor threw the dart, tried to imitate the model, adjusted their dart throwing procedure based on the corrections of the instructor, and finally adjusted their procedure using their own corrections.

This phase model can also describe the process of learning to solve equations. Teachers or peers can solve model equations for the class while the other students observe. Students can imitate the process during class work and receive feedback. During homework, they can practice the process until they have automatized it. Then the students self-regulatively adapt to the variations in problems and conditions of learning.

However, teachers can undermine a students' focus on learning process by their assessment and grading practices. The existing school culture measures student achievement by results on outcome oriented assessment vehicles. Teachers value these results because administrators hold them responsible for student's passing rates. Administrators create curricula which reflect the content of these outcome oriented assessments. Many teachers prepare their students for these standardized tests by creating similar outcome oriented assessments to be used in class on a daily basis. How do these positive valuations of outcome oriented goals by teachers affect student values and goals?

Teacher assessment literature

Teacher evaluations may affect student academic achievement in two ways. First, teacher assessment measures may give the student an advantage if they are consonant with the student's study methods. Second, teacher assessment methods may cause students to change their self-regulatory goals. If the assessment is outcome oriented, the student may switch their focus from strategic processes to outcomes.

Teacher expectations can create positive results. All the literature cited in the strategy use section of this dissertation used verbal persuasion and teacher modeling of strategies to help students learn and use them. Even in those studies which compared two or three strategies (Olshavsky, 1976; Bassler, et al, 1985; Swing, et al, 1988), the researchers or teachers assigned strategies to students and then encouraged them to use whichever treatment they were assigned. The assignment of strategies and encouragement by the teacher indicated to the students that these strategies were important and valuable.

Cornbleth, et al. (1974) and Jussim (1986) suggest that students respond with behaviors which complement and reinforce teacher's expectations. Time that a teacher devotes to a task implies the importance of the task (Slavin, 1987). A student will realize that a topic is important because of the amount of time spent covering it or the number of times the question occurs on tests. These positive teacher valuations could increase the student's valuation of the strategy which then could increase the student's strategy use.

Some forms of self-monitoring have been used as assessment measures. Fontana and Fernandes (1994) taught a self-assessment technique to 354 primary school pupils, ages ten to fourteen. These students did significantly better in assessment tests than did the non-self-assessing group. This experiment, however, self-monitoring phase of self-regulation. Self-monitoring may have produced the positive results rather than assessment practices. The self-monitoring here was teacher prompted and conducted in class.

The effect of teacher assessment practices on student behaviors is cited as a defense of portfolio assessment in such programs as the Vermont Portfolio Assessment Program or the California Math Performance Assessment Project. These portfolios were created in an attempt to assess deeper student understanding of a topic and to overcome test anxiety often associated with standardized tests. Collecting student work accumulated over an extended period of time may change student learning processes. They may be forced to seek a more thorough understanding in one specific task areas in order to create their portfolio projects.

Koretz, et al (1994) reviewed the Vermont Portfolio Assessment Program. Results of their study were inconclusive as to the effect of portfolios on creating deeper understanding. They reported, however, that portfolio testing presented administrative problems. Grading portfolios was more arduous and time consuming. Outcome oriented, standardized tests contain multiple choice or fill in the blank answers which are graded using answer keys and completed on-site in a few hours. Cheating was more difficult to prevent since portfolios were completed outside the school.

Baxter, Shavelson, and Herman (1994) reviewed results from the California math performance assessment project. Sixth grade students were taught by a curriculum of tasks rather than traditional problem sets. They were also assessed by tasks rather than standardized tests. Results of standardized tests administered at the end of the year showed no significant difference between students who had been taught via tasks or by the traditional algorithmic teaching. More importantly, when asked to solve problems presented in the traditional format, Koretz, et al

(1994) and Baxter, et al (1994) found that both the portfolio and traditionally taught groups used the same approaches to solving the problems and made similar errors.

While there is little reported research on manipulating assessment vehicles to affect learning, examination of the school environment reveals a strong effect of assessment on mathematical instruction. "Teaching to the test" and giving student practice assessments using questions from previous standardized assessments is widely perceived as helpful in improving test scores on all education levels (Maslow, 1995). Further proof of this belief is the proliferation of commercial preparation courses (Kaplan courses, SAT prep courses, or Barron's courses) and literature (Barron's, SAT, GRE, MCAT, etc.) which purport to improve their subjects results on these standardized tests. These courses simulate the testing environment and use assessment facsimiles. Advertisements for these courses include statistical information supporting the practice of overtly teaching to the test. However, none of this data has been published in journals.

Estraine (1997) reports that the New York State Department of Education is creating a new mathematics "Test A" which will be implemented in 2001 as a high school graduation requirement. This vehicles asks questions which have several possible correct answers and a rubric assessment formula which awards points based on the depth of the answer. It is designed to follow the National Council of Teachers of Mathematics (NCTM) standards of higher order questions and discourse in mathematics (NCTM, 1991). By introducing this test five years before it will be mandated, the New York State Department of Education hopes to influence the teaching of mathematics. They believe that teachers will be motivated to implement the NCTM standards in their classrooms if the criteria for high school graduation includes a test based on those standards. More high school graduation includes a test based on those standards. More importantly, students will be motivated to learn and use higher order thinking processes if they know that their high school graduation depends on answering these type questions.

The New York State Department of Education had very poor results in their pilot trials of Test A (9% passing the pilot form of Test A vs. 70% of the same population passing the Course II Regents). Their explanation was that the students were not familiar with the format and had not been taught to answer these higher order questions with several possible correct answers which are differentially graded. Teacher questions and classroom assessment vehicles are expected to change to match the questions on the upcoming Test A assessment vehicle. This assessment is expected to change curriculum also (Estraine, 1997).

If assessment affects curriculum and instruction, does it also affect student processes? Would the outcome orientated teacher assessments negate the positive effects of process self-monitoring by students? Would creating process oriented assessments force the students to become more aware of process and increase student self-monitoring of strategies?

These empirical question could be answered if a group of students were given homework which asked questions regarding the process of strategy use. These students would be asked to self-monitor if they used the strategy correctly. A second group of students would be given the same homework problems in outcome oriented form and asked to monitor if they got the correct answer These groups could be sub-divided and one part of each group would be given process oriented weekly assessments while the other subgroup would be given outcome oriented weekly assessments. An outcome oriented pre- and posttest would be given to assess change in academic achievement.

Summary

The literature regarding strategy training suggests increases in mathematical achievement, self-efficacy, goal setting, self-evaluative standards, and intrinsic motivation. However, strategy learning doesn't ensure their implementation by students. They may not value the strategy enough to use it or may lack confidence to implement it without teacher assistance. Self-regulation is needed to insure continued strategy use.

The literature regarding self-regulation suggests it can increase academic achievement and improve self-efficacy, goal setting, and motivation. Of the four self-regulatory processes (self-monitoring, self-evaluation, self-reaction, and feedback) self-monitoring is paramount because of its sequential role. In addition, self-monitoring can be taught in the school environment using self-recording procedures.

The literature on self-monitoring suggests that monitoring strategic process is more productive than monitoring outcome. Without process self-monitoring, incorrect or incomplete strategy implementation may occur. The school environment, however, may make process monitoring difficult because most teacher assessments are outcome oriented.

The literature on teacher assessment practices is inconclusive as to its effect on student achievement. Although teachers report success by "teaching to the test" and successful commercial enterprises continue to prepare students to pass standardized tests by administering facsimile tests, the literature comparing student outcomes when facsimile assessments were used as preparation is inconclusive. Moreover, using facsimile assessments may introduce intervening variables such as increased self-efficacy or decreased test anxiety which may affect academic achievement more than familiarity with test format.

Hypotheses

This dissertation will examine the following hypotheses:

H1) Students who self-monitor will achieve more than those who don't self-monitor.

H2) Students who monitor homework processes will achieve more than those who monitor homework outcomes.

H3) Students who are given process assessments will achieve more than those who are given outcome assessments.

H4) Students who monitor homework processes and take process tests will achieve more than any other group.

H5) Students in each treatment group will achieve more than those in the control group.

Chapter 3

Methods

Sample

The sample consisted of 118 beginning algebra students (49 male, 69 female) ranging in age from 14 to 19 years old (M=16.7). Their ethnic composition was 65% Hispanic, 16% Afro-American, and 19% Asian.

The school is located in a poor neighborhood in a large urban city. The income of 83% of the student's families are below poverty level making them eligible for Federally funding under Project Achieve. The school's population is 40% Hispanic, 39% Asian, 11% Afro-American, 6% Bengali (which are listed as Asian in Board of Education data), and 4% Caucasian. The lower level mathematics classes, however, are predominately Hispanic (see Table 1).

Table 1

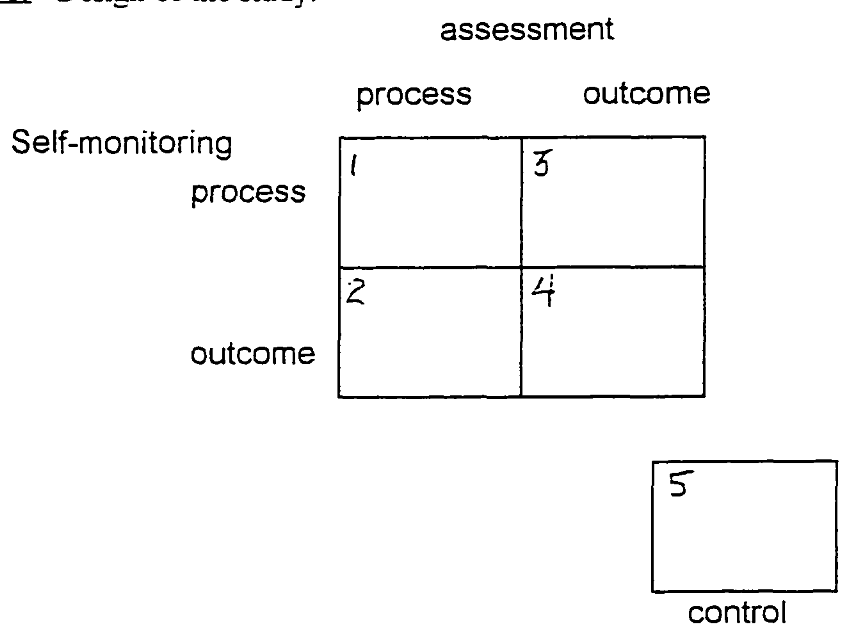
Mean age, gender, and ethnicity of the sample

	Male		Female		total	
	n	M age	n	M age	n	M age
Hispanic	32	17.4	45	17.0	77	17.2
Afro-American	5	16.3	14	16.0	19	16.1
Asian and Bengali	12	15.0	10	14.2	22	15.1
total	49	17.0	69	15.9	118	16.7

Design

A 2 x 2 design crossing the two independent variables, type of self-monitoring with type of assessment, with a control group was used (see figure 1).

Figure 1. Design of the study.



1) Self-monitoring Homework Processes/Process Assessment

2) Self-monitoring of Homework Outcomes/Process Assessment

3) Self-monitoring of Homework Processes/Outcome Assessment

4) Self-monitoring of Homework Outcomes/Outcome Assessment

5) Control

Task Materials

Five types of task materials were provided to each teacher: Curriculum, strategy instruction, homework, homework answers, and weekly assessments.

Curriculum. Each teacher was provided with a curriculum for beginning algebra listing lessons 17 to 28 as outlined by the Superintendency of High Schools for the Borough of Manhattan and the Assistant Principal of Supervision of Mathematics of the high school in which the study occurred (see Appendix A).

An example of the Beginning Algebra curriculum follows:

Lesson	Aim	Development and **pages in Occhiogrosso, et al (1993)**
17	How do we solve equations of the form x + a = b	Solve and check x + a = b where b>a. **Pages 16-19**
18	How do we solve practical problems using x + a = b	Translate English sentences into equations of this type and solve them. **Pages 22-23**
19	How do we solve equations of the form ax = b.	Use reciprocals to solve ax = b where a and be are non-zero and rational. **Pages 48-49**

(continues to lesson 28)

Strategy Instructions. To insure that strategy use was implemented as equally as possible by the teachers, each teacher received a strategy outline (see appendix B) for each lesson. The strategy used for solving equations was a three question technique used by Pysher (1996). The strategy used for solving verbal problems was a key word translation used by Bassler, Beers, and Richardson (1985). These strategies were written on the board during each lesson. Teachers could use the exercise to start the class, as the procedure in the middle of the class, or as the summation at the end of class. An example of strategy handouts follows:

Strategy for Lesson 17

ALL TEACHERS

(Please write this on the board at sometime during the lesson)

We want to end up with x alone on one side of the equation like this

x = (some number)

In order to do this, we ask the following questions

1) What is the operation being done to the variable?

2) What is the inverse operation?

3) What is the new equation when we perform the operation to both sides of the equation?.

Example: $x + 12 = 18$

1) What is the operation? addition

2) What is the inverse operation? subtraction

3) What is the new equation when we perform the inverse operation

$$\begin{aligned} x + 12 &= 18 \\ \underline{-12} &\quad \underline{-12} \\ x &= 6 \end{aligned}$$

Did you write this strategy and examples on the board? Yes _____ No _____

Teacher ________________________ Period ___________

Homework. Outcome oriented homework for each lesson was taken from homework assignments in the PreAlgebra text book used by the school (Occhiogrosso, Epstein, Adrian, Armstrong, Eckhardt, & Genier, 1995). Students were asked to "solve for x", or "write the correct answer". Ten problems per lesson were given in a spiral format. Four problems of the ten covered material from previous lesson, six covered material on the present lesson. To insure that students self-monitored the processes of strategy use, the same problems were used but questions were created by the researcher assessing correct strategy use or the sequence of strategy. The correct answer was never requested in the process oriented homework problems. Each student received outcome or process oriented homework to monitor for each lesson (see appendix C).

Examples of outcome and process homework problems follow:

Outcome Homework 17

Name ________________ Teacher ____________ Period _____

1) $x + 5 = 8$ answer ______

2) $x - 6 = 10$ answer ______

3) $S + 12 = 18$ answer ______

4) $x - 15 = 12$ answer ______

Did I get the correct answers? Yes ___ No ___

Process Homework 17

Name ________________ Teacher ____________ Period ___

1) Answer the following questions for each equation.

a) What is the operation? b) What is the inverse operation? c) What is the new equation when we perform the inverse operation on both sides of the equation?

EXAMPLE $x + 6 = 11$

a) addition

b) subtraction

c) $x + 6 - 6 = 11 - 6$

1) $x + 5 = 8$	2) $x - 6 = 10$	3) $S + 12 = 18$	4) $X - 15 = 12$
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)

Did I follow the strategy outlined in class? Yes ___ No ___

Teacher's modeling of homework answers. To help the students understand how to complete the homework and to increase teacher valuation of outcomes or processes, each teacher was given the answers to the homework for each lesson and asked to write them on the board (see Appendix D).

Examples of outcome and process modeling of homework answers follow.

Lesson 17

Modeling of homework for OUTCOME teachers

Outcome questions ask the student to arrive at the answer.

The examples completed on the board should look like this:

problem

1) $x + 5 = 11$

$$\begin{array}{rcl} x + 5 & = & 11 \\ \underline{-5} & & \underline{-5} \\ x & = & 6 \end{array}$$

Lesson 17

Modeling of homework for PROCESS teachers

These homework assignments ask the student to follow the strategy outlined in class. Spaces with letters of each step are provided for the student to fill in. The examples done on the board should look like this:

(question)	(answer)
1) $x + 5 = 11$	1) $x + 5 = 11$
a)	a) addition
b)	b) subtraction
c)	c) $x + 5 - 5 = 11 - 5$

Did you write this model of the homework on the board? Yes ____ No ____

Teacher ____________________________ Period _____________

Teacher's Weekly Assessments. Each teacher administered three 15 question outcome or process oriented assessment tests, depending on his or her treatment assignment. The outcome oriented tests were taken from Chapter tests in Occhiogrosso, et al (1995). Process assessments were created by the researcher using the same problems as the outcome oriented tests but assessing the steps of the strategy or the correct process of strategy use (see Appendix E).

Name ________________ Test 1 Outcome

1) x - 6 = 11 2) 4x = 24 3) x + 6 = 16 4) A number increase by 24 is 56. Find it.

5) 5(x ÷2) 6) 8 - 6 / 2 ÷ 6 (/ means divide) 7) Eight times a number is 56. Find the number.

Name ________________ Test 1 Process

1) In Problems 1, 2, and 3, List

(a) the operation,

(b) the inverse operation,

(c) then perform the inverse operation for the problems below:

Example: x - 30= 115

a) subtraction

b) addition

c) x - 30 + 30 = 115 + 30

1) x - b = 11	2) 4x = 24	3) x + 6 = 16	4) Translate into mathematics using the key word strategy.
a)	a)	a)	"A number increased by 24 is 56." ____________
b)	b)	b)	
c)	c)	c)	

5) What property does 5(x + 2)= 5x + 10

6) Which operation is performed first in 8 - 6 / 2 + 6? (/ means divide)

7) Translate into math: Eight more than a a number is 56.

Measures

Measures were created to assess mathematical achievement. Each of these measures were given before and after the treatment. A fifteen question, outcome-oriented, pre-test was taken from the unit review tests in Occhiogrosso, et al (1995). The task content was solving one-step equations, two step equations, equations with parenthesis, and verbal problems. A post-test was created by maintaining the same order, difficulty, content, and operations of each problem on the pre-test, but changing one or two numbers in each problem (see appendix F). Gain scores were created by subtracting the pretest score from the posttest score for each subject.

Procedure

This study was conducted in a naturalistic environment. All the procedures normally in place in the school were used. No attempt was made to modify students' assignment to classes, teachers' assignment to classes, teachers' training time, homework, assessments, or teachers' classroom behavior beyond strategy instructions and observations necessary to control internal validity.

Student assignment. Students entering the school were assigned to beginning algebra classes by a diagnostic exam administered by the Assistant Principal of Mathematics. Students were placed in Beginning Algebra classes because they could not solve one-step equations, two step equations, verbal problems, or basic computational skills. In addition, students who had failed the Beginning Algebra class the previous term were assigned to these classes again. Those students who qualified for this level of mathematics were placed into these classes on a first-come, first serve basis until the class reached the maximum number of students allowed by teacher contract guidelines (35) and a new class at that level was opened.

All students in these classes were given permission slips (see Appendix H) to be signed by their parents. The parents of students who did not return their permission slip were telephoned and asked for permission for their child to participate in the study. Written permission slips were then sent by first class mail with return addressed, stamped envelopes enclosed. Phone numbers, phone calling services, and parent/school organizations were made available to the researcher by the administration of the school. Data was not collected for students whose parents did not respond or who denied permission for their children to participate. During the experiment, teachers compiled attendance data. Students who did not attend 50% of the classes were dropped from the study.

Teacher assignment. Permission was obtained from the Principal of the school and Assistant Principal of Mathematics to conduct this study. Teacher assignment to classes is made by the Assistant Principal of Mathematics based on request forms submitted by the 22 teachers in the department or by a rotation policy if there are fewer requests than classes.

Only one teacher in this study requested Beginning Algebra. Others were assigned. The eight teachers assigned to the beginning algebra classes were asked to participate in the study. Two teachers declined. One teacher agreed to be in the study, but was not included because he was a first year teacher which would have made his personal data an outlier in the teacher profile table (see Table 9).

Teachers in the survey were matched by number of beginning algebra classes and randomly assigned to process assessment or outcome assessment treatments. The two teachers with three beginning algebra classes had one class randomly assigned to each self-monitoring condition (processes or outcomes) or the control group. The teacher with two beginning algebra classes had one class randomly assigned to each self-monitoring treatment. The two teachers with only one beginning algebra class were assigned to an assessment and a self-monitoring treatment so that there were at least two teachers assigned to each of the five cells in the design: Self-monitoring homework processes/Process assessments, Self-monitoring homework outcomes/Process assessments, Self-monitoring homework processes/Outcome assessments, Self-monitoring homework outcomes/Outcome assessments, and a Control group.

All teachers agreed to outline the sample problems and strategies provided with each lesson, to assign the homework provided by the researcher, and to list the homework answers on the board. In all other areas of class work, they were told to use their usual teaching methods for the five weeks of this study. The control group teachers taught the same curriculum using their own homework problems and lesson plans without the strategy handouts, self-monitoring homework, or process assessment vehicles.

Teacher training. All teachers participated in two hours of training conducted during their lunch periods. The homework assignments, the procedure for checking homework answers, and the use of the strategy handouts was modeled. Outcome assessment teachers were asked to focus on getting the correct answers and encouraged to say phrases like "correct procedures result in correct answers", "work carefully", and "check your answers". Process teachers were asked to focus on the correct sequence and choice of strategy. They were encouraged to say phrases like, "Which step is first?", "Which step is second?", "focus on the process, not the final answer", and "ask the strategy questions".

Administration of the pre- and posttests was modeled. The researcher was available on a daily basis to answer questions, to provide help, to explain the administration of assessments and homework, and to exchange task materials. Each teacher was observed twice on videotape, on audiotape, or in person to insure correct use of the strategy instructions, homework, and homework answer models, and to create a process score (see Table 9). After each observation, feedback was given to the teacher regarding the process of administering strategy instruction, homework, and homework correction.

Homework assignments. Teachers gave the lesson's homework assignment (see appendix C) to each student in every class except on assessment days. Teachers reported that this sample of students did not achieve a 50% homework completion rate before the beginning of the experiment. Therefore, an in-class self-monitoring procedure was dev.eloped. Teachers asked students to take out their homework at the beginning of class. While the teacher circulated around the room taking attendance, students who had completed homework were noted. Only at-home self-monitors were included in homework completion percentages. Those students who completed homework at home were given a non-algebraic, computational, or calculator problem to solve while the other students were given the previous day's homework and asked to complete the problems and answer the self-monitoring question in-class. Students exchanged papers and corrected their peer's work as suggested by Zimmerman, Bonner, and Kovach (1996). All homework was collected and those students who completed their work outside class were recorded as at-home self-monitors. Those students who completed their work in the class were classified as in-class self-monitors. All completed work was given to the researcher daily. Since the homework was spiraled to include previous work, only questions dealing with equation solving or verbal problems were included in the raw score.

Teacher assessment. Assessments were given after lesson 20, lesson 24, and lesson 28. All assessments were provided by the researcher (see Appendix E). Those teachers assigned to the outcome assessment treatment gave outcome based tests. Those teachers assigned to the process assessment treatment gave tests which assessed knowledge of strategies or sequence of steps in the process without asking the final outcome. All tests were collected, graded, and recorded by the researcher. The tests were returned to the teacher the next day and a review of the test was conducted by the teacher to reinforce the assessment treatment. No percentage grades were calculated.

The study lasted five weeks. Teachers administered a pre- and posttests (see appendix F). The tests were given to the researcher to grade and record.

Teacher observations. The researcher observed each teacher twice by videotape, audio tape, or in person to complete a survey (see appendix I) which tallied:

1) The number of problems discussed.
2) The number of times the strategy was repeated.
3) The number of times synonyms of strategy or process were used.
4) The number of phrases said encouraging the use of strategy.

A "Process Score" was created by dividing the total of items 2, 3, and 4 by item 1 (see table 9).

Control group. Teachers in the control group followed the same curriculum using their own homework, their own tests, and no self-monitoring task. They administered the pretest before Lesson 17 and posttest after Lesson 28 and three of their own assessments at the end of lesson 20, lesson 24, and lesson 28 to match the treatment groups. One teacher used computer assisted teaching (PLATO) while another used algebra tiles, cooperative learning, and student explanations of homework on the board.

Chapter 4

Results

The results will be presented for each hypotheses. Where hypotheses could be tested using factorial analysis, analyses of covariance (ANCOVA) were performed. Since covariance analysis did not provide adjusted means for making pairwise comparisons, gain scores were computed and used as the basis for statistical analysis to test hypotheses between groups and individual cells. A priori analyses of the data, along with teacher biographical data and process scores created from teacher observations will follow the results of the hypothesis. Means and standard deviations for pretests, posttests, and gain scores for the experimental and control groups are listed in Table 2.

Table 2

Means, standard deviations, and gain scores on pre- and posttest for the experimental and control groups

Condition	n		pretest	postest	gain
Self-monitoring processes	24	M	3.93	7.22	3.29
Process assessments		SD	3.40	3.27	
Self-monitoring outcomes	24	M	3.21	5.13	1.92
Process assessments		SD	2.28	3.22	
Self-monitoring processes	19	M	4.33	6.96	2.63
Outcome assessments		SD	3.06	3.52	
Self-monitoring outcomes	26	M	1.24	3.01	1.77
Outcome assessments		SD	2.88	3.65	
Control	25	M	4.65	4.89	.24
		SD	4.23	3.79	

Hypotheses

H1) Students who self-monitor will achieve more than those who don't self-monitor.

H3) Students who are given process assessments will achieve more than those who are given outcome assessments.

To test Hypothesis One and Hypothesis Three, an analysis of covariance (ANCOVA) was performed on the posttest scores using pretest scores as a covariate to assess the main effects and interactions of self-monitoring and teacher assessment (see table 3). The main effect of the ANCOVA for self-monitoring was highly significant. Students who self-monitored homework processes significantly outperformed those who monitored homework outcomes.

Table 3

Main effects of self-monitoring and teacher assessment with interactions for the posttest, covarying the pretest.

Source of Variation	Sum Sqs	df	Mean Square	F	Sig of F
Covariates					
Prescore	375.42	1	375.42	54.96	
Main effects	78.46	2	39.23	5.74	.005*
Self-monitoring	71.58.	1	71.58	10.48	.002*
Assessment	2.64	1	2.64	.39	.54
Interactions					
Self-monitoring with assessment	.07	4	.08	.01	.92
Residual	601.09	88	163.98	24.01	<.001

* significant

Table 3 also shows the main effect of the type of teacher assessment on academic achievement was not significant, and there was no interaction between self-monitoring types and assessment types. Thus, Hypothesis Three was not supported.

H2) Student who monitor processes will achieve more than those who monitor outcomes.

Cells were collapsed to compare the gain scores of all self-monitors of processes vs. all self-monitors of outcomes. A t-test was performed on means of gain scores of these two groups (see Table 4). Students who self-monitored processes significantly outperformed those who self-monitored outcomes $t(91)= 3.33$.

Cells were collapsed to compare the gain scores of all students receiving process assessments vs. those receiving outcome assessments. There was no significant difference in gain scores. Thus H3 was not upheld (see Table 4).

Table 4

Comparison of Academic Gains Between Self-Monitoring Conditions

	n	M	SD	t	p
All students who self-monitored processes	43	3.01	3.28	3.33	<.01*
All students who self-monitored outcomes	50	1.84	3.05		
All students given process assessments	48	2.60	2.76	1.13	ns
All students given outcome assessments	45	2.13	3.38		

* significant

H4) Students who monitor homework processes and are given process tests will achieve more than any other group.

A priori t-tests of contrasts were performed comparing the means of academic gain scores between groups. Students who self-monitored homework processes and were given process assessments (M= 3.29) achieved significantly greater gains in mathematical achievement than students in the control group (M= .24) , students who self-monitored homework outcomes but were given process assessments (M= 1.92), and students who self-monitored homework outcomes and were given outcome assessments (M= 1.77).

Although students who self-monitored homework processes while being given process assessments showed more achievement gain than those who self-monitored homework process while being given outcome assessments, this contrast did not reach significance (see Table 5). Thus, Hypothesis Four was generally supported although one contrast did not reach significance.

Table 5

Comparison of Academic Gains Between Treatment Groups

Treatment comparison	t	p
Self-monitoring processes/Process assessment vs. Self-monitoring outcomes/Process assessment	2.24	.03*
Self-monitoring processes/Process assessment vs. Self-monitoring processes/Outcome assessment	.80	.43
Self-monitoring processes/Process assessment vs. Self-monitoring outcomes/Outcome assessment	2.02	.04*
Self-monitoring processes/Process assessment vs. Control group	6.64	.001*

* significant

Note: Separate variance t-values were used to test the significance of each contrast.

H5: Students in all treatment groups will achieve more than those in the control group.

A priori t-tests of contrasts were performed on the means of academic gain scores between each treatment group and the control group (see Table 6).

Table 6

Comparison of Academic Gains Between Each Self-Monitoring Condition and Non Self-Monitors

Treatment comparison	t-value	p
Self-monitoring process/Process assessment vs. Control Group	6.64	.001*
Self-monitoring outcome/Process assessment vs. Control Group	2.75	.009*
Self-monitoring process/Outcome assessment vs. Control Group	2.92	.007*
Self-monitoring outcome/Outcome assessment vs. Control Group	2.05	.043*
All self-monitoring groups vs. Control Group	2.63	.008*

* significant

Table 6 shows that each self-monitoring conditions achieved significantly higher gain scores than the non-self-monitoring control group. When all treatment cells were collapsed together and a t-test performed, students who self-monitored (M= 2.38) had highly significant gains in academic achievement when compared to the control group (M= .24). Thus, Hypothesis One was given additional support.

Additional Analysis

The academic gains by students in sub-groups of the sample were subjected to further analyses. Students who self-monitored at home were compared to those who self-monitored in class across all treatment groups. Academic gains in classes of the two teachers who taught both self-monitoring conditions plus a control group were compared. Differences in gain scores of teachers within treatment groups, biographical data provide by teacher questionaires, and teacher process scores created from observations were examined to test internal validity of the treatment.

Within Treatment Comparisons of At-Home vs. In-Class Self-Monitoring.

Each treatment group was subdivided into at-home and in-class self-monitoring. Several t-tests of contrasts were performed between these two types of self-monitoring within each condition. The at-home self-monitoring students (M= 3.31, SD= 2.89) displayed higher achievement gains than in-class self-monitors (M= 1.61, SD= 2.72) when all groups were collapsed together, $t(91)$= 2.92. However, within group comparisons showed that only those students who were given outcome assessment and monitored homework processes at home performed significantly better than students in the same treatment who monitored in class (see Table 7).

Table 7

Means and standard deviations with a priori t-tests comparing gain in achievement between type of self-monitoring within each group

Condition		n	M	SD	t	p
Self-monitoring processes	at home	11	3.27	2.00	.05	.96
Process assessment	in class	13	3.30	1.25		
Self-monitoring processes	at home	14	2.64	2.27	1.74	.10
Outcome assessment	in class	10	0.90	2.64		
Self-monitoring outcomes	at home	9	4.22	3.63	2.20	.04*
Process assessment	in class	10	1.20	2.25		
Self-monitoring outcomes	at home	8	3.50	5.12	1.34	.19
Outcome assessment	in class	18	1.25	3.09		
total	at home	42	3.31	2.89	2.92	.004*
	in class	51	1.61	2.72		

* significant

Students gains in self-monitoring treatments and control groups having the same teacher. Two teachers, one assigned to process assessment, the other assigned to outcome assessment, had three classes in beginning algebra. These teacher's classes were randomly assigned to each condition: self-monitoring homework processes, self-monitoring homework outcomes, and control. Several t-tests of contrasts were performed on means of student academic gain scores between each condition and the control group for each teacher (see table 8).

Students of Teacher 1 (process assessment). As Table 8 shows, students given process assessments who self-monitored either homework outcomes and homework processes achieved significantly higher academic gain scores than did the non-self-monitoring control group.

Students of Teacher 4 (outcome assessment). Outcome-assessed students who self-monitored processes did significantly better than the control group. Those students that self-monitored outcomes achieved greater gain scores than the control group, but significance was not reached (see Table 8). Thus the same pattern of results occurred for both teachers.

Table 8

Student academic gain scores across self-monitoring types having the same teacher

	Treatment type	n	M	SD	t	p
Students of Teacher 1 (Process Assessment)	Self-monitoring process	12	3.67	1.37	4.54	.00*
	Self-monitoring outcomes	10	2.40	2.46	2.80	.02*
	Control group	12	.38	1.93		
Students of Teacher 4 (Outcome Assessment)	Self-monitoring process	9	3.66	4.47	2.03	.04*
	Self-monitoring outcomes	10	2.55	4.96		
	Control group	13	.08	1.32		

* significant compared to the control group

Tests for internal validity. In order to test internal validity in this field study, student academic gain scores for teachers within the same treatment group were compared.

Two teachers were assigned to each treatment cell in the study. Several t-tests of the contrasts between means of academic gain scores within cells were performed. There were no significant differences for means of academic gain scores for classes taught by different teachers within the same treatment group (see Table 9). These results suggest internal validity was maintained.

Table 9

Means and standard deviations of gain scores of different teachers within the same treatment

		n	M	SD
Self-monitoring process	Teacher 1	12	3.67	1.37
Process assessments	Teacher 2	12	2.92	1.78
Self-monitoring outcome	Teacher 1	10	2.40	2.46
Process assessments	Teacher 5	14	1.57	2.62
Self-monitoring process	Teacher 3	10	1.70	1.33
Outcome assessments	Teacher 4	9	3.66	4.47
Self-monitoring outcomes	Teacher 3	16	1.12	2.80
Outcome assessments	Teacher 4	10	2.55	4.96
Control group	Teacher 1	12	.38	1.33
	Teacher 4	13	.08	1.93

Teacher personal data, observational data, and process rating.

In addition, data from a school records and process scores created from observations were examined. There were no significant differences in number of problems per class, number of key words per class, number of positive phrases per class, and process scores between teachers in the study (see Table 10). These results also suggest that internal validity was maintained in the treatment's implementation.

Teachers in this study had an average of 21 years experience in teaching and taught the course an average of 12 times. All teachers used the lesson plan format requested by the district and school's Assistant Principal of Supervision of Mathematics. They all wrote the Aim of the lesson followed by a "Do Now", then a Development. Teacher 1, 4, and 5 used the strategy plan in the daily lesson handout as a Do Now. Teacher 2 and 3 used the prescribed strategy in the Development. All teachers corrected homework by listing the answers on the board. In-class self-monitoring of homework became the Do Now for teacher 1, 2, 4, and 5. Teacher 3 conducted this procedure after the development.

Teachers were allowed to choose from three observation methods: videotape, audiotape, or in-class visits. Teacher 2, 3, and 4 were observed by in-class visits by the researcher. Teacher 1 was videotaped. Teacher 5 felt that the intrusion of a video camera operator or another colleague would be disruptive, so she was audiotaped. All tapes were coded by the researcher.

Table 10

Teacher biographical data and process scores

T	years teaching	times teaching	problems per class		key words per class		positive phrases		process score
			M	SD	M	SD	M	SD	
1	12	7	8.00	1.00	42.5	1.50	7.00	2.00	6.19
2	23	11	8.00	2.00	33.0	3.00	6.50	.50	4.93
3	13	10	11.00	2.00	25.0	5.00	1.00	1.00	2.36
4	30	16	8.50	.50	17.0	1.00	1.5	.50	2.18
5	30	18	9.00	1.00	25.0	1.00	2.0	1.00	3.00

Total mean and standard deviation for process score

M = 3.63 SD = 1.58

Chapter 5

Discussion

This study suggests that self-monitors, whether of processes or outcomes, whether monitoring at home or in class, performed significantly better than students who do not self-monitor. Students who self-monitor homework processes obtain significantly higher academic gains than those who self-monitor homework outcomes regardless of type of assessment used by their teachers. These increases in academic achievement among self-monitors of homework processes occurred in all classes and for all teachers. Self-monitoring homework at home yields greater academic gains than self-monitoring homework in class. This discussion will suggest possible explanations for the results of each hypothesis followed by an examination of additional analyses.

Discussion of Hypotheses

H1) Students who self-monitor homework will achieve higher gain scores than those who don't self-monitor homework. This hypothesis was confirmed. Collapsing all four self-monitoring conditions together yielded highly significant differences in gains in mathematical achievement for self-monitors when compared with the no self-monitoring control group. In addition, comparing students of teachers who taught both self-monitoring condition and a control group showed that their self-monitoring students achieved significantly higher academic gain scores than did students in their respective no self-monitoring control group. This suggests that increases in achievement were not caused by teacher personality or assessment type.

The explanations for significantly increased achievement by self-monitors of processes will be outlined in the discussion of Hypothesis Two. The conformation of Hypothesis One suggests that, while self-monitoring homework

homework processes may be best, self-monitoring homework outcome is better than no self-monitoring at all. Self-monitoring homework outcomes may force the student to check their work more often or work more slowly. Each of these effects would insure more correct strategy use by self-monitors of outcomes than by students who do not self-monitor. However, this study did not observe students as they completed their homework. Further research should be conducted regarding student attention, environmental control strategies, and help-seeking behaviors while completing homework.

H2) Student who monitor homework processes will achieve higher gain scores than those students who monitor homework outcomes The two-way ANCOVA's comparing posttest scores covarying the pretest, showed that self-monitoring of homework processes had a highly significant effect on mathematical achievement. This achievement advantage by students who self-monitored processes is particularly noteworthy because the measures of academic achievement were outcome-oriented. Clearly, focusing on homework processes does not prevent students from performing well on outcome-oriented tests. Teachers' and administrators' fears that students would perform poorly because type of homework or class work does not match the type of assessment seem to be unwarranted. These results suggest that teachers should modify homework assignments to focus on practicing strategy steps instead of outcomes.

Hypothesis Two is further supported by comparing within group differences of gain scores of students who were taught by the same teacher. Under both process and outcome assessment conditions, self-monitoring homework processes yielded higher academic gain than self-monitoring homework outcomes. Students in both self-monitoring groups significantly outperformed those in the control group.

However, while students in matching self-monitoring treatments taught by different teachers had similar academic gain score means, their standard deviations were significantly different ($F(19) = 10.65$, $p < .05$ for self-monitoring processes; $F(18) = 4.05$, $p < .05$ for self-monitoring outcomes). These within group differences in standard deviations may be explained by differing pedagogical procedures associated with student retention and self-regulatory processes.

Observational data collected from classes of the teacher with the smaller standard deviation showed that students received constant verbal reminders of "what is the operation, what is the inverse, what do we do to both sides" with every problem. This repetition of strategic procedures may have helped these students remember how and when to apply the strategy more than students of a less repetitive teacher. Some students of the latter teacher gained as much as nine points between pre- and posttest while others did not improve at all. Future research should examine the effect of repetition of strategic procedures on strategy use.

Another possible reason for the positive results achieved by students who self-monitored homework processes may be their increased homework completion. More homework was completed by students who self-monitored process (40%) than students who monitored outcome (24%) or students in the control group (10%). Reasons for differences in homework completion rates were explored. Fifteen students who had self-monitored homework process were asked "What are the advantages of self-monitoring the process of using strategies?" The three most frequent answers to the first question were "I get the right answers more often (13)", "it is easier to get the answer to each step than it is to get the complete answer right away" (11), and "I can get the right answer if I just use the right strategy" (7).

The first two answers indicate student perceptions of utility and economy for strategy use (Paris, Neuman, and Jacobs, 1995). The third answer refers to attribution of failure to incorrect strategy use as outlined by Clifford (1986) and Zimmerman and Martinez-Pons (1992). These researchers suggest that students who attribute their academic failures to poor strategy use have greater expectations for the future and more positive self-judgments than those students who attributed failures to lack of effort or low ability.

H3) Students given process assessments will achieve higher gain scores than those given outcome assessments. Cells were collapsed across self-monitoring types to see the effect of teacher assessment practices on the entire sample. Type of assessment had a positive but non-significant effect on academic gain scores. Further evidence of the lack of effect of type of assessment on academic achievement is found in teacher anecdotal information regarding student reactions to assessments reported in the discussion of Hypothesis Four and Hypothesis Two. Students seem to adjust to teacher expectations of how to answer test questions.

A possible explanation for this result is that the treatment may have been too short (5 weeks). Other studies which such as Carpenter, et al (1989) and Cobb, et al.(1992) lasted a year or more. Future research should implement longer treatment periods to better test this hypothesis.

H4) Students who monitor homework processes and take process assessments will achieve higher gain scores than any other group. This hypothesis was generally upheld. Students who self-monitored homework processes and were given process assessments achieved significantly higher academic gain scores than self-monitors of homework outcomes in both assessment conditions and by the no self-monitoring control group. Students who self-monitored homework processes and who were given process oriented assessments tended to scored higher (25%) than those who self-monitored the same homework but were given outcome oriented tests. However, significance was not reached (p=.09). These differences in mean gain scores suggest that matching type of homework with type of assessment may increase student learning.

Many administrators suggest that matching instruction and unit assessment to standardized assessment vehicles increases academic achievement because this practice avoids student confusion at test time. Indeed, anecdotal information provided by teachers showed that, when given the weekly assessments, students who self-monitored homework processes frequently asked "Don't you want the answer?" when given the process assessments. Despite completing similar items in their homework, these student seemed to doubt that a unit test would contain problems asking only to list the strategy without giving the final answer. Teacher's anecdotal information also reported that, when given the outcome oriented posttest at the end of the five week treatment, students who self-monitored homework processes asked, "Do we write the answers or just the strategy?" even though the instructions clearly called for final answers only. This suggests that these students were applying the steps for self-monitoring processes even on outcome oriented tests. This is a desired feature of a process approach.

This reported confusion, however, did not prevent the self-monitors of processes from obtaining higher academic gain scores on the outcome oriented tests than either the self-monitors of outcomes or students who did not self-monitor. The belief that test scores will increase by giving homework and class work which replicate assessment vehicles may not be valid for students who become self-regulatory. A better explanation for self-monitors of processes who were given process oriented tests performing better than those self-monitors of processes who were given outcome oriented tests may be that taking and reviewing these process oriented assessments provided more exposure to the skills necessary to self-monitor processes. The students who self-monitored homework process but were given outcome oriented assessments were not afforded this additional practice. Research should be conducted on larger samples to further test if matching type of assessment to type of self-monitoring can produce significantly greater academic gains.

H5) Students in all treatment groups will achieve more than those in the control group. Pairwise comparisons of gain score means between each treatment group and the control group showed all self-monitoring groups significantly outperformed the control group (see Table 5).

Greater achievement by all treatment groups may indicate that self-monitoring processes increases strategy use as outlined in the discussions of H1 and H4. Homework completion and time of task may have been increased through strategy attribution as suggested by Zimmerman and Kitsantas (1997). Increases in achievement among outcome self-monitors may have occurred because they were prompted to recheck their work when completing their self-monitoring question. They may have been forced to work more carefully. Future research should observe student behaviors while doing homework to determine if the process of strategy recall and the amount of reworking of problems are affected by variables other than self-monitoring.

Discussion of Additional Research

Several statistical analyses were performed on sub-groups of this sample. Students in each treatment group were subdivided into those who self-monitored homework at home and those who self-monitored homework in class.

Biographical data and process scores among teachers in the sample were compared. The results of these comparisons are presented below.

Students who self-monitored homework at home achieved higher gain scores than those who self-monitored homework in class. Included in the self-monitoring treatment groups were in-class self-monitors and at-home self-monitors. As a group, students who self-monitored at home achieved significantly higher gains in mathematical achievement. However, although the at-home self-monitors consistently created higher gains in academic achievement than did the in-class self-monitors, only the self-monitoring homework processes/outcome assessments students reached significance when compared within cells. This sub-group had the greatest gain score for the at-home self-monitors (see Table 7). However, there were large standard deviations and small sample sizes in these sub-groups. Further research should be conducted with more students in each condition to increase the power of statistical analyses.

Teachers report that they have difficulty getting completed homework from this population (see Limitations of the Study). Should teachers spend class time completing yesterday's homework? The increase in academic achievement reported here by students who self-monitored in-class compared to that of the no self-monitoring control group suggests that introducing and practicing homework processes self-monitoring skills may be worth the class time needed to teach them.

These results suggest that the gains in achievement for all self-monitoring groups might be even greater if more students in those treatments self-monitored at home. Why do some students fail to complete homework? Student valuation of homework (Smith, 1992), automatization of strategies (Zimmerman & Kitsantas, 1997) and better self-regulatory processes (Zimmerman, Bonner, & Kovach, 1995) may be necessary to complete homework out of class. These self-regulatory processes include environmental factors such as parental support and establishing a consistent study time and place. Whatever the reason, the lesson illustrated here is to create a behavior, personal, and environmental support system which enables students to complete their homework.

Tests of internal validity. Biographical data and process scores among teachers were compared. There were no significant differences in years teaching, times teaching the subject, number of key words, number of problems, number of positive phrases, or process scores of each teacher (see Table 9). There were no significant differences in means of gain scores between teachers within each treatment group (see Table 8). These results suggest that teacher variability was controlled. It should be noted however that, while significance was not reached, teachers who assigned process oriented homework to their students ranked first, second, and third in process score while teachers who assigned outcome oriented homework ranked fourth and fifth. Future research should examine the hypothesis that type of homework assigned increases teacher's process oriented classroom behaviors.

Teacher One rated the highest process score. She created a verbal rule out of the equation solving strategy and recited it with every problem. This repetition created very high tallies for use of key words. She also gave pep talks to encourage strategy use, thus increasing her verbal encouragement rating. Since her group performed the best, her students may have better remembered the sequence and correct implementation of the strategy because of these repetitions. Her verbal encouragement could have increased student self-efficacy to try the strategy. Future research should examine the hypothesis that constant verbal repetition of strategies and verbal encouragement increases student strategy use. Because there were only five teachers in this study, this research should be replicated with a larger pool of teachers to extend both internal and external validity.

Limitations of this study

This was a field study. Efforts to implement the treatment uniformly may have been compromised by school procedures which affect administrator, teacher, or student behaviors.

Administrator behaviors. Classroom management and student time on task may have been affected by programming practices. This study was conducted in a neighborhood zone school with an open admission policy. Students were programmed into and out of the target classes during the experiment. Although data from these transitional students were not included in this study, teachers had to take class time to admit, assess, and assign previous work to these late admits. Transitional students may also affect social interactions in the class which might affect student learning and teacher's classroom management procedures.

Teacher behaviors. Distrust between teachers and administrators may have affected assignment to treatment conditions. Two teachers who were assigned beginning algebra courses asked not to be considered for the study. They felt they had an adversarial relationship with the administration and did not want data kept on their classes despite reassurances of confidentiality. Two other teachers agreed to participate only after assurances that they would be exempted from their yearly observation during the study. All teachers who were videotaped or audiotaped wanted the tapes back or taped over after coding. Perceived administrative pressure could have created a self-selected sampling bias on the part of the teachers.

Student Behaviors. Student variables which could have affected internal validity are prior knowledge, attendance, and homework completion. While many students programmed for beginning algebra may be on grade level, others may not understand basic addition, subtraction, multiplication, or division. Only 28% of the school's target population who took the district-wide eighth grade mathematics proficiency test scored above the 50^{th} percentile. This sample had a history of truancy and previous mathematical failures in the junior high school which may have an created a negative affect towards mathematics. Difference in student's prior knowledge is reflected in the large standard deviations for academic gain reported for all groups.

Student attendance and homework completion may have created sampling bias. These data do not include the 41 students who were listed on register in these classes during the experiment who were absent from the pre- or posttest or who did not attend 50% of the classes. These absences may have been caused by program changes to or from another class, transfers to another school, matriculation after the term started, cutting classes, or illness. As with attendance, homework completion for this population is poor. Many of these students did not value homework completion or do not see a causal connection between homework completion and academic achievement. Students who did feel at-home study is important, may lack the necessary environmental structure and help-seeking aides that facilitate homework completion.

The final limitation of this study was length of treatment. This study lasted only five weeks. A longer study would have allowed other mathematical tasks to be studied. In addition, more weekly tests could better assess the effect of process vs. outcome assessments on student achievement and self-processes.

Educational implications

Despite the limitations caused by administrative procedures, teacher behaviors, or lack of student's prior knowledge, attendance, and homework cited above, this study had very positive educational results. These poor, urban, minority students improved their academic achievement by self-monitoring homework process even though the measures of achievement were outcome oriented. These results suggest that teachers can focus on homework processes without fear of decreasing the student's score on standardized tests. Since even in-class self-monitoring of homework processes improved achievement more than no self-monitoring, teachers can take class time to teach skills which increase self-monitoring of homework processes and allow students to practice these skills on unfinished homework.

Increased homework completion is important in the learning of mathematics as shown by Chou (1991), Smith (1992), O'Melia and Rosenberg (1994), and Olympia, Sheridan, Jepson, and Andrews (1994). Unfortunately, modern society is decreasing the student's personal experience with mathematics. Basic mathematics skills such as algebra are not perceived as relevant to student's lives. Even simple computational experiences are reduced by use of credit cards, calculators, and scanners. Process oriented homework and assessments increased the students' exposure to mathematics. This study showed that students who monitored homework processes completed more homework and obtained higher academic achievement than both self-monitors of homework outcomes or students who did not self-monitor. This study also showed that at-home self-monitors obtained greater academic achievement than in-class self-monitors but both were more successful than non-self-monitors.

Increases in academic achievement in beginning algebra may increase these students' interest in enrolling in upper lever high school mathematics courses which Edwards' (1996) analysis of the National Assessment of Educational

Progress (NAEP) survey suggests is the most significant predictor of increased mathematical achievement on standardized tests.

Research implications

The limitations of this study caused by administrator, teacher, or student behaviors listed previously point out the difficulties of conducting research in schools. In the real world of an inner city school, students are admitted to class after the term starts, are programmed out of classes midterm, do not attend regularly, do not complete homework, and have varying levels of ability within the same class. Adversarial relationships between teachers and administrators exist. Some teachers do not want to change their classroom style or rewrite lesson plans. Teacher incentives may be needed for them to give up preparation periods, stay after school, or work on the weekends to learn new pedagogical methods.

Despite these limitations, this study demonstrated that internal validity can be controlled. The Methods and Procedures listed here operated within the parameters of an existing curriculum, existing administration structure for teacher and student assignment to classes, existing teacher attitudes and beliefs, and existing student behaviors and beliefs. The Strategy Instructions and Homework were taken from lesson plans and homework provided in existing textbooks. Teacher training was conducted during lunch periods without using teacher's preparation periods or staff development time.

This study suggests areas for future research. What is the effect of verbal repetition of strategic procedures on strategy use? Which homework completion behaviors other than self-monitoring affect academic achievement? How does self-monitoring process affect attribution of failure? Would the non-significant trends reported in this study such as increased academic achievement for at-home self-monitors become significant if the pool of teachers were increased? Would a longer treatment period significantly increase the effect of assessment on academic achievement? Would a different socio-economic sample yield different results? Future research should also examine how strategy learning and self-monitoring affect various self-processes such as goal grade, satisfaction level, self-efficacy, and intrinsic motivation.

Answers to these hypotheses will provide a greater understanding of the impact of self-monitoring on student achievement. To encourage this research, strategy instructions, curriculum, assessments, and both process and outcome homework are included in the appendices.

Appendix A

Curriculum For Lessons 17-28 in Beginning Algebra for Superintendency of Manhattan

		Pages 92-95, 188-9
17	How do we solve equations of the form x + a = b?..........	..solve and check x + a = b where b > a. Pages 16-19
18	How do we solve practical problems using x + a = b?....	..translate English sentences into equations of this type and solve them. Pages 22-23
19	How do we solve equations of the form ax = b?.............	..use reciprocals to solve ax = b where a and b are rational (a non-zero). Pages 48-49
20	How do we solve practical problems using ax = b?.......	..use equations of the form ax=b to solve verbal problems. Cooperative learning groups fit into this lesson. Pages 54-55, 59
21	How do we solve equations of of the form ax + b = c?......	..use inverses TWICE to solve ax+b=c, where a, b and c are whole and x>0. Pages 74-77, 188-9
22	How do we solve practical problems using ax + b = c?...	..use equations of the form ax+b =c to solve verbal problems. Cooperative learning groups fit into this lesson. Pages 77, 85
23	How do we solve equations which contain like terms?....	..solve equations which contain like terms on one side of the equation. Pages 80-83
24	How do we solve word problems with like terms?............	..solve verbal problems leading to equations with like terms on one side Pages 83-85
25	How do we solve equations which contain like terms on both sides?.................	..use additive inverses and addition or subtraction of monomials to solve equations with variables on two sides Pages 228-229
26	How do we solve word problems leading to equations with variables on both sides?.....	..use equations containing variables on both sides to solve verbal problems. Start assigning homework involving multiplying decimals - for lesson #29 Pages 8-10, 34-43
27	How do we solve equations containing parentheses?......	..solve equations using the distributive law as well as additive and multiplicative inverses Pages 411, 414-415
28	How do we solve word problems leading to equations with parentheses?.................	..solve verbal problems using equations containing ONE grouping symbol. Pages 416-417
29	How do we solve decimal equations?..................	..solve decimal equations by clearing decimals and applying previous rules. Pages 36-37, 48-49, 57
30	How do we solve word problems leading to decimal equations?	..solve verbal problems involving decimal equations. Use coop. groups. Pages 56-59
31	What are the different subsets of the whole numbers?...	..subdivide the set of whole numbers into the subsets of odd and even positive integers. ..represent consecutive integers algebraically ..same for consecutive evens and odds Pages 92-93
32	How do we solve number problems? ..	..solve number problems algebraically using forms recently taught.

Appendix B

Strategy Handouts for Lessons 17-28

STRATEGY FOR LESSON 17

ALL TEACHERS
PLEASE WRITE THIS ON THE BOARD AT SOME TIME DURING THE LESSON

We want to end up with x alone on one side of the equation.

$$x = \text{some number}$$

In order to accomplish this task, we ask the following questions

1) What is the operation being done to the variable?

2) What is the inverse of that operation?

3) What do we have left when we perform the inverse operation to both sides?

Example: $x + 12 = 18$

1) What is the operation? addition

2) What is the inverse operation? subtraction

3) $x + 12 - 12 = 18 - 12$

$x = 6$

Did you write this strategy and example on the board? Yes ___ No _

Lesson 18

ALL TEACHERS
PLEASE WRITE THIS ON THE BOARD AT SOME TIME DURING THE LESSON

STRATEGY FOR LESSON 18

What operation is suggested by the word "INCREASED"?

answer ____________ (addition)

Can we think of any other words which mean addition?

(List them)

What operation is suggested by the word "DECREASED"?

answer ____________ (subtraction)

Can we think of any other words which mean subtraction?

(List them)

Did you write this strategy and example on the board? Yes ___ No

Teacher ________________ Period ______________

Lesson 19

ALL TEACHERS

PLEASE WRITE THIS ON THE BOARD AT SOME TIME DURING THE LESSON

STRATEGY FOR LESSON 19

We want to end up with x alone on one side of the equation

x = some number

In order to accomplish this task, we ask the following que[illegible]

1) What is the operation being done to the variable?

2) What is the inverse of that operation?

3) What do we have left when we perform the inverse operation to sides?

Example $4x = 16$

1) multiplication

2) division

3) $\frac{4x}{4} = \frac{16}{4}$

Did you write this strategy and example on the board? Yes ___

Teacher ________________ Period ________________

Lesson 20

ALL TEACHERS
PLEASE WRITE THIS ON THE BOARD AT SOME TIME DURING THE LESSON

STRATEGY FOR LESSON 20

What operation is suggested by the word "TIMES"?

answer ____________ (multiplication)

Can we think of any other words which mean multiplication?

(List them)

What operation is suggested by the word "half of"?

answer ____________ (divided by 2)

Can we think of any other words which mean division by 3, 4, c
other number?

(List them)

Can we think of any other words which mean division?

(List them)

Did you write this strategy and example on the board? Yes ___ N

Teacher ________________ Period ______________

Lesson 21

All teachers:

PLEASE PUT THE BOARD FOR THE CLASS

Here is the strategy for two-step equations.

Example $4x + 8 = 16$

1) Which operation should we eliminate first?

Use our strategies from last week.
a) What is the operation?
b) What is the inverse operation?
c) What is the result when we perform the inverse operation on both sides of the equation.

2) What is our new equation?

3) What do we do now?

Use our strategies from last week.
a) What is the operation?
b) What is the inverse operation?
c) What is the result when we perform the inverse operation on both sides of the equation.

then work out this example

REMEMBER TO MODEL THE HOMEWORK FOR WHICHEVER GROUP YOU ARE IN (OUTCOME VS. PROCESS).

LESSON 23

All teachers:

PLEASE WRITE THIS ON THE BOARD

1) How many x's remain after we simplify:

a) x+x = 18 ___ Using to represent x, draw the equation.

b) 4x+x-3x = 40 ___ Using to represent x, draw the equation.

c) x+5-2x+3x = 21 ___ Using to represent x, draw the equation.

2) Write the simplified expression for

1a) 1b) 1c)

(You can use algebra tiles, to expand the x's so that they have no coefficient)

REMEMBER TO MODEL THE HOMEWORK FOR WHICHEVER GROUP YOU HAVE.

LESSON 24

All teachers:

PLEASE WRITE THIS ON THE BOARD

1) Use our key words we learned last week to translate these words into mathematical symbols

a) "Is" = (=) b) "times" = (x) c) "Increase" = (=)

d) "a number" = (x) e) "a number added to a number" = (x + x)

f) "three times a number added to two times the same number" = (3x+2x)

2) Write in English using our key work "translations".

a) x + x b) x − x c) 3x + 2 d) 4x + 3x

REMEMBER TO MODEL THE HOMEWORK FOR WHICHEVER GROUP YOU HAVE.

LESSON 25

We want to illustrate equations using a see-saw. As we solve the equation, create the new picture of the see-saw.

All teachers, please write this on the board.

1) Using ▯ = x and O to represent numbers, draw a see saw to represent:

$3x = 15$

what is the operation?

What is the inverse?

What do we get when we perform the inverse?

$3x + 6 = 15$

what is the operation?

What is the inverse?

What do we get when we perform the inverse?

$3x + 5 = x + 15$

HOW DO WE MOVE VARIABLES AND NUMBERS ACROSS THE EQUAL SIGN?

what is the operation?

What is the inverse?

What do we get when we perform the inverse?

Remember to correct my typographical errors when modeling the homework.

LESSON 26

We want to reenforce the meaning of words used for mathematical operations.

All teachers, please write on the board.

Translate to mathematics

A)

"is" "times" "a number" "twice a number" "decrease"

"itself" as in "a number added to itself"

B)
"Three times a number increased by 6 is 24"

"Three times a number added to the number is 24."

"Three times a number is 6 more than twice the number."

How do we move variables and numbers across the equal sign?

Remember to model the homework for each group.

HOMEWORK 27

We are trying to introduce the distributive property to get rid of parenthesis.

ALL TEACHERS, PLEASE WRITE ON THE BOARD

1) Using □ to represent x and ○ to represent the number 1, draw

a) $x + 2$ b) $4(x + 2)$ c) $4(x + 2) = 28$

How do we simplify $4(x + 2)$?

Help
mske sure to put the box for "x"
and the circles for the number
in the homework

Remember to model the homework for each group.

LESSON 28

We want to explain how parenthesis is expressed in verbal sentences.

ALL TEACHERS, PLEASE WRITE ON THE BOARD

1) a) Which words indicate operations in:
Eight is added to a number. The result is tripled. The resulting answer is 45. Find the number."

b) Write an equation for this expression. (Let x = the number)

c) How is this equation different from 3x + 8 = 45?

2) a) Which words indicate operations in:

Jose is 8 years older than Juan. Maria is 2 times as old as Jose. Maria is 30. How old is Juan?"

Using the information above, guess the ages:

Juan's age	Jose's age	Maria's age
5		
10		
	12	
		30

Remember to model the homework for each group.

Appendix C

Homework Assignments

Name ________________ Teacher ______________ period __

Outcome homework
Homework 17

1) $x+5=8$ answer __________

2) $x-6=10$ answer __________

3) $s+12=18$ answer __________

4) $x-15=12$ answer __________

5) 5^2 answer __________

6) $(6-4)^2$ answer __________

7) $8 - 6 / 3 - 2$ answer __________

8) $6(x-1)$ answer __________

Did I get the correct answers? ____ yes ____ no

Outcome Homework 18

1) A number increased by 4 is 6. Find the number.

answer ________

2) A number decreasd by 10 is 20. Find the number.

answer ________

3) Six more than a number is 14. Find the number.

answer ________

4) Eight less than a number is 10. Find the number.

answer ________

5) $x-6=32$ answer ________

6) $x+9=51$ answer ________

7) $10 + 5 \times 3 + 8$ answer ________

8) $\frac{1}{2} \cdot \frac{3}{8}$ answer ________

Did I get all the answers correct? ____ Yes ____ No

Name ________________ Teacher ____________ Period __

Outcome Homework 19

1) $3x=18$ answer ________

2) $6x=540$ answer ________

3) $.3y=1.8$ answer ________

4) $12x=144$ answer ________

5) $(3.8)^3$ answer ________

6) $5(9-6)$ answer ________

7) A number increased by 15 is 45. answer ________

8) $x+3.8=5.9$ answer ________

Did I get the answers correct? ____ yes ____ No

Name ___________________ Teacher ______________ period ___

Outcome Homework 20

1) Three times a number is 12. Find the number. answer _______

2) Twice a number is 18. Find the number. answer _______

3) Four and one-half times a number is 27. Find it. answer _______

4) .8 of a number is 16. Find the number. answer _______

5) $\frac{1}{4} / \frac{1}{2}$ answer _______

6) $17x = 51$ answer _______

7) $(5^2)^3$ answer _______

8) $\frac{1}{2} + \frac{1}{3}$ answer _______

Did I get the answers correct? _____ yes _____ no

Name ____________________ Teacher ________________ Period______

Number attempted ___________ Number correct ___________

Outcome Homework 21

1) $2x+2=14$ answer ___________

2) $9x-18=54$ answer ___________

3) $23x-1500=3600$ answer ___________

4) $5x+5=105$ answer ___________

5) $8 + 10 / 2 - 13$ answer ___________

6) $(5-3)^2$ answer ___________

7) $x-17=12$ answer ___________

8) $32x=512$. answer ___________

Did I get the answers correct? ____ yes ____ no

Name ______________________ Teacher ________________ Period______

Number attempted ____________ Number correct ___________

Outcome Homework 22

1) Six times a number increased by 12 is 72 Find the number.

answer ____________

2) Twelve times a umber decreased by 9 is 27. Find it.

answer ____________

3) 13 is 8 less than 3 times a number. Find it.

answer ____________

4) Videotapes cost 3 dollars each. There is a one-time membership fee to the video club. If Jose paid $25 to join the club and rent tapes, how many tapes did he rent?

answer ____________

5) Which law? $(a+b)+c=a+(b+c)$

answer ____________

6) Which law? $(a+b)=(b+a)$

answer ____________

7) Which law? $5(4+6) = 20 + 30$

answer ____________

8) $3x-24=60$.

answer ____________

Name ______________________ ______ ________________ _______

Number attempted ____________ Number ______ ___________

Outcome Homework 23

1) $x+x+x=18$ answer __________

2) $5x-4x+3x=24$ answer __________

3) $3x+2x+x=18$ answer __________

4) $9x+x-6x=40$ answer __________

5) $9x-30=15$ answer __________

6) 15^2 answer __________

7) $(x-3)7$ answer __________

8) $\frac{1}{2}\cdot\frac{2}{3}\cdot\frac{1}{4}$ answer __________

Did I get the correct answers? ____ yes ____ no

Name ______________________ Teacher ________________ Period _______

Number attempted ____________ Number correct ___________

Outcome Homework 24

1) A number added to twice the number is 27. Find the number.

answer ____________

2) Certain aliens are having a party. Four are in the room, 2 exit, 3 fly into the room. There are now 65 legs in the room. How many legs does each alien have?

answer ____________

3) $7^2 - 5^2$

answer ____________

4) 30x-126

answer ____________

5) x-123=146

answer ____________

6) x/2 =8

answer ____________

7) I have 3 of the same coins in my pocket. I found 28 more in my drawer. I spent 11 of them on lunch. I now have $2.00. What type of coin is this?

answer ____________

8) We are playing poker. I bet some nomey. Each time my turn comes around, I bet twice what I bet on my last turn. After 4 turns, I have bet a total of $6.00. How much did I bet in my 1st turn?

answer ____________

Did I get the correct answers? ____ yes ____ no

Name _ ____________________ Teacher __________________ Period_____

Number attempted ____________ Number correct ___________

Outcome Homework 25

1) $2x+4=x+8$ answer _________

2) $2x=x+7$ answer _________

3) $3x+3x=5x+5$ answer _________

4) $6x-4=14$ answer _________

5) $3x=2x+4$ answer _________

6) $8x-6x-3x=33$ answer _________

7) $3^2 - 2^3$ answer _________

8) Three times a number increased by 5 is 17. Find the number.

answer _________

Did I get the correct answers? ____ yes ____ no

Name ______________________ Teacher ________________ Period_______

Number attempted ____________ Number correct ___________

Outcome Homework 26

1) Three times a number is 16 more than twice the number. Find the number.

answer __________

2) Four video rentals cost $12. more than 2 video rentals. How much does it cost to rent one movie?

answer __________

3) Fifeteen less than 6 times a number is equal to 6 more than 4 tim the number. Find the number.

answer __________

4) Using 1) as and example, make a verbal problem to express $3x=2x+6$

answer __________

5) $x+2x+3x=4x+22$

answer __________

6) $16-8/2+4$

answer __________

7) $5^2 - 2^3$

answer __________

8 $4(x+2)$

answer __________

Did I get the correct answers? ____ yes ____ no

Name ______________________ Date _______

Number attempted ____________ Number correct __________

Outcome Homework 27

1) $3(x+2)=18$ answer ___________

2) $6(x-3)=12$ answer ___________

3) $4(3+x)=36$ answer ___________

4) $.03x+.2=5$ answer ___________

5) 8^2 answer ___________

6) $15+20/2+3$ answer ___________

7) $7x-4=143$ answer ___________

8) $2x+3x = 4x+6$ answer ___________

Did I get the correct answers? ____ yes ____ no

Name ________________________ Teacher __________________ Period_______
Number attempted _____________ Number correct ___________

Outcome Homework 28

1) Five is added to a number. The result is then doubled yielding 26. What was the original number?

answer __________

2) Jose is 6 years older than Juan. Maria is 3 times as old as Jose. How old is Juan if Maria is 30 years old?

answer __________

3) Kim earned 35 dollars per week more than Li. After 5 weeks Kim ha 300 dollars. How much does Li earn per week?

answer __________

4) The sum of a number and 12 is then multiplied by 4. The result i: 64. Find the number.

answer ___________

5) $7(x-3)=21$

answer ___________

6) $5x-32=48$

answer ___________

7) $x+2x+3x=4x+28$

answer ___________

8) Twice a number decreased by 12 is 16. Find the number.

answer ___________

Did I get the correct answers? ____ yes ____ no

Process Homework 17

Did I use the stategies outlined in class? ______Yes ______No

1) Answer the following questions for each equation.
   a) What is the operation?
   b) What is the inverse operation?
   c) What is the result when we perform the inverse operation on bot sides of the equation.

EXAMPLE $x + 5 = 11$

a) addition
b) subtraction
c) $x + 5 - 5 = 11 - 5$

1) $x+5= 8$	2) $x-6=10$	3) $x+12=18$	4) $x-15=12$
a)	a)	a)	a)
b)	b)	b)	b)

Did I follow the strategy outlined in class? Yes ____ No ____

5) What does the "3" in 5^3 mean?

6a) What do we do first in $(6-4)^2$? ______________

6b) What do we do first in 8 - 6 / 3 -2? ______________

Process Homework 18
Did I use the strategies outlined in class? ___ Yes ___ No

1a) What operation does "increase suggest in "A number increased by 4 is 6?"

1b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________
1) ________________ 2) ____________ 3) ________________

2a) What operation does "decreased" suggest in "A number decreased by 6 is 8?"

2b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________
1) ________________ 2) ________________ 3) ________________

3a) What operation does "more than" suggest in "Six more than a number is 14?"

3b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________
1) ________________ 2) ________________ 3) ______________

4a) What operation does "less than" suggest in "8 less than a number is 10?"
Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________
1) ________________ 2) ________________ 3) ________________

Process Homework 19)
Did I use the strategies outlined in class? ___ Yes ___ No

A) Answer the following questions for each equation.
  a) What is the operation?
  b) What is the inverse operation?
  c) What is the result when we perform the inverse operation on both sides of the equation.

EXAMPLE $4x = 16$
a) multiplication
b) division
c) $\frac{4x}{4} = \frac{16}{4}$

1) $3x = 18$	2) $6x = 540$	3) $.3x = 1.8$	4) $12x = 144$
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)

Did I follow the strategy outlined in class? Yes ____ No ____

5) How is $.3x = 1.8$ similar to $3x = 18$?

6) Estimate $(3.8)^3$ by rounding off 3.8 to the nearest integer.

7) Estimate x in $x + 3.8 = 6.9$ by rounding off 3.8 and 6.9 first.

8a) What operation does "increased by" suggest in "A number increased by 15 is 45."

____

8b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ______________
1) ________________ 2) ________________ 3) ________________

Process Homework 20

Did I use the strategies outlined in class? ___ Yes ___ No

1a) What operation is suggested by "times in "three times a number is 12"?

1b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________

1) ________________ 2) ________________ 3) ________________

2a) What operation is suggested by "twice in "twice a number is 18?"

2b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________

1) ________________ 2) ________________ 3) ________________

3a) What operation is suggested by "of" in ".8 of a number is 16"?

3b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________

1) ________________ 2) ________________ 3) ________________

4a) What is the decimal equivalent of "four and a half" in "four and a half times a number is 27?"

4b) Write the equation for this sentence and fill in the blanks below using the strategy
1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ____________

1) ________________ 2) ________________ 3) ________________

5) Write in complete sentences how to divide one fourth by one half.

6) What does the "3" mean in $(5^2)^3$?

Name ______________________ Teacher ________________ Period______

Number attempted ____________ Number correct __________

Process Homework 21

A) Answer the following questions for each equation.

a) Which operation has to be eliminated first?

b) What is the operation?

c) What is the inverse operation?

d) What is the result when we perform the inverse operation on both sides of the equation.

e) What is our new equation?

f) What do we do now?

EXAMPLE $4x + 8 = 16$

a) addition of 8
b) addition
c) subtraction
d) $4x + 8 - 8 = 16 - 8$
e) $4x = 8$
f) go back to question a).

1) $2x+4 = 14$	2) $9x-18 = 84$	3) $23x-1500 = 3600$	4) $5x+5 = 105$
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)
d)	d)	d)	d)
e)	e)	e)	e)
f)	f)	f)	f)

Did I use the strategies outlined in class? ___ Yes ___ No

Process Homework 21 continued

3) Fill in the chart

x	$2x + 4$	$9x - 18$	$5x + 5$
3			
10			
	64		

4) Which operation has to be done first in $8 + 10 / 2 - 13$?

Process Homework 22

EXAMPLE $4x + 8 = 16$

a) addition of 8
b) addition
c) subtraction
d) $4x + 8 - 8 = 16 - 8$
e) $4x = 8$
f) go back to question a).

1) $6x+12 = 72$	2) $12x-9 = 84$	3) $13 = 3x - 8$	4) $8x+4 = 16$
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)
d)	d)	d)	d)
e)	e)	e)	e)
f)	f)	f)	f)

6) Fill in the chart:

Law	# of numbers	# of operations
commutative	_____	_______
___________	3	1
distributive	3	______

Did I use the strategies outlined in class? ___ Yes ___ No

Name ______________________ Teacher _________________ Period_______

Number attempted ____________ Number correct ___________

Process Homework 23

1) How many x's remain after we simplify:

a) x+x+x = 18 ___ b) 9x+x-6x = 40 ___ c) 3x+2x+x = 18 ___

d) 5x-4x+3x = 20 ___

2) Write the simplified expression for

1a) 1b) 1c) 1d)

3) Write in complete sentences how you would multiply two thirds by one half.

4) How many terms in the answer to (x-3)7 ?

5a) How many operations in 9x-30 = 15?

b) What are they?

c) What are their respective inverses?

d) Which should be performed first when solving the equation?

6) How many operations in a + (b c) = (a + b) + c?

7) What law does 6) illustrate?

Did I use the strategies outlined in class? ___ Yes ___ No

Process Homework 23

8) (8)(19) is easier to multiply if 19 is thought of as (20 -1). Why?

9) Use the strategy above to multiply:

a) (6)(29)   b) (8)(15)   c) (5)(99)   d) (17)(20)

Name ______________________ Teacher ________________ Period _______

Number attempted ____________ Number correct ___________

Process Homework 24

1a) Find the sum of the coefficients of x in the following problems

a) $x+x+x$ b) $5x-4x+3x$ c) $3x+2x+x$ d) $17.4x - 8.6x - 12$

3) Answer the following questions for each equation below

a) What is the sum of the coefficients of x?

b) What is our new equation?

c) What is the operation indicated?

d) What is the inverse operation?

e) What is the result when we perform the inverse operation on both sides of the equation.

EXAMPLE $4x + 8x = 36$

a) 12
b) $12x = 36$
c) multiplication
d) division
e) $\frac{4x}{4} = \frac{16}{4}$

A) $x+x+x = 18$	B) $5x-4x+3x = 24$	C) $3x+2x+x = 18$	D) $18x-13x+16x = 84$
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)
d)	d)	d)	d)
e)	e)	e)	e)
f)	f)	f)	f)

Did I use the strategies outlined in class? ___ Yes ___ No

Process homework 24

4a) Write an equation for "4 times a number added to 3 times the number, decreased by 2 times the number is 320.

____

5) What does the 2 mean in $7^2 - 5^2$ *?*

6) Using your experiences renting videotapes as an example, write a verbal problem to express $3x + 2.80 = 14.80$ *where x in the price of one tape.*

TEST 2 tomorrow

Name ________________________ Teacher __________________ Period_______
Did I use the strategies outlined in class?

_____ Yes ____ No

Number attempted ____________ Number correct ___________

Process Homework 25

1) Using = x, draw a see saw to represent:

a) $2x + 5 = x + 8$ b) $3x + 3x = 5x + 5$ c) $8x + 6x = 3x + 33$

2) How can we move all the x variables in 1) to the left hand side of the equation?

3) Answer the following questions for each equation below.

a) What is our equation after we move all the variables to one side of the equation?

b) What is the sum of the coefficients of x now?

c) What is our new equation?

d) What is the operation indicated?

e) What is the inverse operation?

f) What is the result when we perform the inverse operation on both sides of the equation.

EXAMPLE $4x + 8x = 36 - 6x$

a) add 6x to both sides.
b) $4x + 8x + 6x = 36 - 6x + 6x$
c) $18x = 36$
d) multiplication
e) division
f) $\frac{18x}{18} = \frac{36}{18}$

Process homework 25

A) $2x + 5 = x + 8$

a)

b)

c)

d)

e)

f)

B) $3x + 3x = 5x + 5$

a)

b)

c)

d)

e)

f)

C) $8x + 6x = 3x + 33$

a)

b)

c)

d)

e)

f)

4a) What are the operations indicated in $6x - 4 = 14$?

b) What are the inverse operations?

c) Which is done first?

Process Homework 26

Name ________________________ Teacher __________________ Period________
Did I use the strategies outlined in class?

_____ Yes _____ No

Number attempted _____________ Number correct ____________

1a) Which words indicate operations in "three times a number is 15 more than twice the number"?

b) Write the equation for this expression.

2a) Which words indicate opeations in "15 less than 6 times a number is equal to 5 more than 4 times the number"?

b) Write the equation for this expression.

3) Create a verbal problem for a) $3x = 2x + 6$

b) $4x + 22 = x + 2x + 3x$.

4) a) What is our equation after we move all the variables to one side of the equation?

b) What is the sum of the coefficients of x now?

c) What is our new equation?

d) What is the operation indicated?

e) What is the inverse operation?

f) What is the result when we perform the inverse operation on both sides of the equation.

Process Homework 26

A) $3x = 2x + 6$

a)

b)

c)

d)

e)

f)

b) $4x + 22 = x + 2x + 3x$

a)

b)

c)

d)

e)

f)

5a) Which operation is done first in
16-8/2+4

b) Which is performed second?

Process Homework 27

Name ______________________ Teacher ________________ Period______

Did I use the strategies outlined in class?

_____ Yes ____ No

Number attempted ____________ Number correct ___________

1) Using to represent x and to represent the number 1, draw

a) $x + 2$ b) $4(x + 2)$ c) $4(x + 2) = 28$

d) $3(x + 2)$ e) $6(x - 3) = 12$ f) $6x - 3x = x + 12$

2) How many x variables do we have in each expression in problem 1 above?

a) b) c) d) e) f)

2) Solve $4(x + 3) = 36$ by substituting y for $(x + 3)$ in the equation.

a) What is 4y equal to? __________

b) What is x equal to? __________

3a) What are the operations indicated in $5x - 15 = 55$?

b) What are the inverse operations?

c) Which is done first?

Process Homework 27

4) Fill in the chart

Law	# of elements	# of operations
Distributive		
Associative		
Commutative		

5) What does the 3 mean in $\left(\frac{1}{4}\right)^3$? What is the answer?

Process Homework 28

Name ______________________ Teacher ________________ Period_______

Number attempted ____________ Number correct ___________

Did I use the strategies outlined in class?

_____ Yes ____ No

Process Homework 28

1) Which words indicate operations in:

a) Five is added to a number. The result is doubled. The resulting answer is 26. Find the number."

b) Write an equation for this expression. (Let x = the number)

c) Jose is 6 years older than Juan. Maria is 3 times as old as Jose. Maria is 30. How old is Juan?"

d) Write an equation for this expression. (Let x = Juan's age)

e) The sum of a number and 12 is then multiplied by 4. The result is 64."

f) Write an equation for this expression. (Let x = the number)

Process Homework 28

4) Using = x, and = the number 1, represent

a) $7(x+2) + 21$ b) $x+2x+3x = 4x+28$ c) Twice a number decrease by 12 is 16.

Appendix D

Modeling of Homework Answers

Lesson 17

MODELING OF HOMEWORK FOR OUTCOME TEACHERS

Outcome questions ask the student to arrive at the answer.

The examples done on the board should look like those below

(question)	(answer)	
1) x + 5 = 11	1) x + 5 = 11 - 5 -5 x = 6	Answer __6_

MODELING OF HOMEWORK FOR PROCESS TEACHERS

These homework assignments ask the student to follow the strategy outlined in class. Spaces with letters of each step is provided for the student to fill in.

The examples done on the board should look like those below

(question)	(answer)
1) x + 5 = 11	1) x + 5 = 11
a)	a) addition
b)	b) subtraction
c)	c) x + 5 - 5 = 11 - 5

Did you write this model the homework by using examples on the board

Yes ___ No ___

Teacher ______________________ Period ____________

Lesson 18

MODELING OF HOMEWORK FOR OUTCOME TEACHERS

These questions ask the student to arrive at the answer.

The examples done on the board should look like those below

(question)

1) A number increased by 5 is 11. What is it?

(answer)

$$\begin{aligned} x + 5 &= 11 \\ -5 &\quad -5 \\ \hline x &= 6 \end{aligned}$$

Answer __6__

MODELING OF HOMEWORK FOR PROCESS TEACHERS

These homework assignments ask the student to follow the strategy outlined in class. Spaces with letters of each step is provided for the student to fill in.

The examples done on the board should look like those below

1) Answer the following questions for each equation.
   a) What is the operation?
   b) What is the inverse operation?
   c) What is the result when we perform the inverse operation on both sides of the equation.

EXAMPLE $x + 5 = 11$

a) addition
b) subtraction
c) $x + 5 - 5 = 11 - 5$

Did you write this model the homework by using examples on the board?

Yes ___ No ___

Teacher ______________________ Period ___________

Lesson 19

MODELING OF HOMEWORK FOR OUTCOME TEACHERS

These questions ask the student to arrive at the answer.

The examples done on the board should look like those below

(question)
1) $4x = 16$

(answer)

$$\frac{4x}{4} = \frac{16}{4}$$

Answer __4__

MODELING OF HOMEWORK FOR PROCESS TEACHERS

These homework assignments ask the student to follow the strategy outlined in class. Spaces with letters of each step is provided for the student to fill in.

The examples done on the board should look like those below

1) Answer the following questions for each equation.
   a) What is the operation?
   b) What is the inverse operation?
   c) What is the result when we perform the inverse operation on bot. sides of the equation.

EXAMPLE $4x = 16$

a) multiplication
b) addition
c) $\frac{4x}{4} = \frac{16}{4}$

Did you write this model the homework by using examples on the board?

Yes ___ No ___

Teacher ______________________ Period ____________

Lesson 21

MODELING OF HOMEWORK FOR OUTCOME TEACHERS

These questions ask the student to arrive at the answer.

The examples done on the board should look like those below

(question)
1) Half a number is 16. Find it.

(answer)
Let x = number

$$\frac{x}{2} = 16$$

$$2\left(\frac{x}{2}\right) = (2)(16)$$

answer x=16

MODELING OF HOMEWORK FOR PROCESS TEACHERS

These homework assignments ask the student to follow the strategy outlined in class. Spaces with letters of each step is provided for the student to fill in.

The examples done on the board should look like those below

1a) What operation is suggested by "half" in "half a number is 16?"

________________ (division)

1b) Write the equation for this sentence and fill in the blanks below using the strategy

1) what operation?
2) what is the inverse operation?
3) What is the result when we perform the inverse operation on both sides?

Equation ______________

1) __________________ 2) __________________ 3) ________________

$(\frac{x}{2} = 16$ 1) division 2) multiplication 3) $2(\frac{x}{2}) = (2)(16))$

Did you write this model the homework by using examples on the board?

Yes ___ No ___

Teacher ______________________ Period ____________

Lesson 22

All teachers:

Please write on the board.

1) What words indicate operations in:

a) Eight times a number increased by 10 is 74

b) Twice a number decreased by 9 is 27.

2) Write equations for 1a) 1b)

To solve these equations, REMEMBER OUR STRATEGIES.

Answer the following questions for each equation in 2 above.

a) Which operation has to be eliminated first?
b) What is the operation?
c) What is the inverse operation?
d) What is the result when we perform the inverse operation on both sides of the equation.
e) What is our new equation?
f) What do we do now?

REMEMBER TO MODEL THE HOMEWORK

Appendix E

In-Class Assessments

Name ____________________ Test 1 Outcome

solve for x\

1) $x - 6 = 11$ 2) $4x = 24$ 3) $x + 6 = 16$ 4) 4^4

5) $5(x + 2)$ 6) 8 - 6 / 2 + 6 (/ means divide) 7) $(3.2)^2$

8) $(2^3)^2$ 9) $\frac{1}{4} + \frac{1}{6}$ 10) $\frac{1}{4}$ / $\frac{1}{8}$ (/ means divide)

11) A number increase by 24 is 56. Find it.

12) Eight less than a number is 104. Find it.

13) Three and one half times a number is 14. Find it.

14) .8 of a number is 32. Find it.

15) A quarter of a number is 20. Find the number.

Name ________________ *Test 2* *Outcome*

Solve for x

1) $3x-2 = 13$ 2) $16 + 20 / 4 - 13$ 3) $5x-13 = 105$ 4) $4x - 24 = 72$

5) $3x+6x-2x = 49$ 6) $8(x+2)$ 7) $10x- 3x-4x = 18$ 8) $6^2 - 2^5$

9) $\frac{3}{4} \cdot \frac{1}{2} \cdot \frac{3}{8}$ (. means multiply) 10) Which law? $(5+4)+2 = 5+(4+2)$

11) Six times a number increased by 12 is 72. Find it.

12) Three times a number added to four times the number is 35. Find the number.

13) Twelve less than 3 times a number is 18. Find the number.

14) When twice a number is subtracted from 6 times the number, the answer is 48. Find the number.

15) Seven less than a number is 16. Find it.

Name _______________ Test 3 Outcome

1) $3x + 6x + 12x = 420$ 2) $9x = 1827$ 3) $.5x = 12$ 4) $4^3 - 3^3$

5) 32 / 4 + 8 x 3 (/ means divide)
(x means multiply) 6) $6x-4 = 14$ 7) $7x = 4x+18$

8) $1.2x+4.8 = 14.4$ 9) $4(x-4) = 16$ 10) $(6-2)^2 + 8 / 2$ (/ means divide)

11) Which law: $5(x-2) = 5x-10$ a) associative b) distributive c) commutative

12) Five is added to a number. The result is multiplied by 4. That answer is 44. Find the number.

13) Thirty per cent of a number increased by 15 results in 21. Find the number.

14) Six times a number decreased by 13 is 5. Find the number.

15) A number plus 6 times the number decreased by 3 times the number is equal to twice the number plus 34. Find the number.

Name ___________________ Test I Pr...

1) List: (a) the operation, (b) the inverse operation, (c) then perform the inverse operation for the problems below.
Example x-30 = 115 a) subtraction b) addition c) 115 + 30 = 145

1) x - 6 = 11	2) 4x = 24	3) x + 16 = 26	4) x = 8
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)

5) Which operation is performed first in 8 - 6 x 2 + 6? (x means multiply)

6) Which operations are indicated below:

a) A number decreased by 24 is 56 ________

b) Eight less than a n mber is 104 ________

c) Three and one half times a number is 14 ________

d) .8 of a number is 32. ________

e) A quarter of a number is 20 ________

7) Write the equations for the sentences in problem 6.

a) b) c) d) e)

Name ________________________ Test 2 Process

1) List (a) the operations indicated, (b) the inverse operations necessary, (c) then the order of the inverse operation for the problems below.

Example $\frac{x}{4}-3 = 5$ a) subtraction of 3 and division by 4

b) addition of 3 and multiplication by 4

c) add three to both sides first, then divide by 4

1) $3x-2 = 13$ 2) $5x-15 = 105$ 3) $4x+24 = 72$ 4) $\frac{x}{2}+11 = 23$

1)	2)	3)	4)
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)

5) What is the coefficient in front of the variable when you simplify?

a) $6x+3x-2x = 49$ ______ b) $8(y+2)$ ______ c) $10x-3x-4x = 18$ ____

6) Circle the words indicate operations in the problems listed below?

a) Three times a number added to four times the number is 35.

b) Twice a number is subtracted from 6 times a number result is 48.

c) Twelve less than three times a number is 18.

7) Write the equations for:

6a) 6b) 6c)

Name ________________________ Test 3 Process

1) In the problems below, list

(a) the coefficient of the variable after you simplify the expression.

(b) the equation after you simplify.

(c) the operations necessary to solve the equation.

(d) the solution.

Example $4x + 4x - 5x + 10 = 32$

a) the coefficient after we simplify x is 3

b) $3x + 10 = 32$.

c) divide by 3, subtract 10 from both sides.

d) $x = 7.33333333333333333333333333...$

1) $3x+6x+12x = 420$	2) $7x = 4x+18$	3) $1.2x+4.8 = 14.4$	4) $4(x-4) = 16$
a)	a)	a)	a)
b)	b)	b)	b)
c)	c)	c)	c)
d)	d)	d)	d)

2) What is the difference between equation a and equation b?

a) Three times the sum of a number and six is 18

b) The sum of three times a number and six is 18.

3) Use the distributive property to expand:

a) $2(x + 5)$ b) $3(2x - 8) = 6$ c) $\frac{(4x-8)}{4}$

4) Circle the words that indicate operations then write the equation in the space next to the problem.

a) Three times the sum of a number and 4 is 30.

Equation ______________

b) Four times a number added to 7 is 20 more than three times the number.

Equation ________________

c) Six more than a number is 20 less than two times the sum of the number and 3.

Equation ___________________

Appendix F

Pre and Posttest

Name ________________ Pretest

solve for x in these problems:

1) $3x = 18$ 2) $\frac{x}{3} = 6$ 3) $12x - 2x + 8 = 98$ 4) $3x + 6 = 21$

5) $42 = 5x + 2$ 6) $5x + 3x = 64$ 7) $5x + 8 = x + 40$ 8) $\frac{x}{4} + 9 = 17$

9) $x+x+2+x+3 = x+11$ 10) $5(x-3) = 16$ 11) $6x-4x+3 = x+12$

Solve these verbal problems

12) Three times a number decreased by 10 is 8. Find it.

13) One number is added to 6 more than twice itself. The answer is 27. Find the number.

14) One number is 16 less than four times itself. Find the number.

15) I rented 12 videotapes. There was a $3.30 service charge, a $50.00, one-time, club membership that I had to buy, and an 8 percent tax on the video rental only (not on the membership or the service charge). If the total bill was $59.78, how much was each videotape?

Name ____________________ Posttest Teacher ________________

Period __________

solve for x in these problems:

1) $4x = 24$ 2) $\frac{x}{2} = 6$ 3) $10x - 3x + 21 = 28$ 4) $x + 6.3 = 7.1$

5) $54 = 6x + 2$ 6) $7x + 4x = 66$ 7) $5x + 8 = x + 44$ 8) $\frac{x}{4} + 9 = 17$

9) $x+x+2+x+4 = x+12$ 10) $8(x-3) = 64$ 11) $6x-2x+4 = 3x+12$

Solve these verbal problems

12) Three times a number decreased by 10 is 11. Find it.

13) One number is added to 5 more than twice itself. The answer is 29. Find the number.

14) One number is 24 less than four times itself. Find the number.

15) I rented 10 videotapes. There was a $3.30 service charge, a $50.00, one-time, club membership that I had to buy, and an 8 percent tax on the video rental only (not on the membership or the service charge). If the total bill was $61.94, how much was each videotape?

Appendix G

Consent Forms

The Graduate School and University Center
of the City University of New York

Parent or Guardian Consent Form

I agree to allow my child to participate in a study to be conducted by Ernest Pysher, a Mathematics teacher at Seward Park High School and doctoral student at the Graduate School and University Center of the City University of New York. The study is being conducted with the permission of the administration and faculty of Seward Park High School. The study will examine homework self-monitoring by students and assessment by teachers. My child will be given homework in mathematics along with self-regulation questionaires to complete. In no way will the results of these assessments affect my child's grade.

I realize that participation in this study is voluntary and I understand that my child may withdraw from the study at any time without any penalty. All the information about my child will be kept confidential and his or her identity will not be revealed to any individual.

If I need to have additional information about this study, I am free to call 212-674-7000, extension 330 to talk with Mr. Pysher.

Homework completion is very important in mathematics. The teacher hopes to gain more understanding about self-monitoring the process of strategy use in solving equations.

Signature of Parent ______________________________

If you are interested in the results of this study, please write your name and address in the space provided below. A summary will be sent to you. No individual names or scores will appear.

HOMEWORK CONTRACT
Permission slip

Dear Parents:

Completing homework has been shown to be one of the best predictor of success in school. Your child should have homework every night in each subject. You can help them by setting aside enough time and a quiet place for them to complete their work,

Seward Park has formed alliances with many of the universities in the New York area to aide in your child's education. We have homework helpers and tutors from NYU's Americorp program, afterschool and weekend programs at Kingsborough Community College, and family learning research projects through City University.

At all times the anonymity of the students, teachers, and school is protected in all research data results. We hope you will help us by allowing your child to participate in these projects.

If you have any questions, please feel free to call me at 674-7000, ext. 330. We hope we all can cooperate to assure your child gets the best possible education.

Thank you.

Ernest Pysher
Testing coordinator
Seward Park High School

____
Parent's name

____
Student's name

Appendix H

Teacher Observation Form

:

Teacher Observation Form

Teacher ______________________ Period ______________

Number of problems ______

Number of key words said ________________

Number of synonyms for key words ________________

Number of positive phrases encouraging strategy use. ____________

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