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Kristina R. Baker

Eastern Illinois University

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**The Effects of Self-Monitoring with Accuracy Feedback versus Self-Monitoring
with Corrective Feedback on Students' Performance in Mathematics**

BY

Kristina R. Baker

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Specialist in School Psychology

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

2005
YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
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Running head: SELF-MONITORING AND FEEDBACK ON MATHEMATICS PERFORMANCE

The Effects of Self-Monitoring with Accuracy Feedback versus Self-Monitoring with
Corrective Feedback on Students' Performance in Mathematics

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Abstract

The current literature suggests that when students are engaged in metacognitive activities, such as self-assessment, self-explanation, *monitoring*, or revising; their learning is enhanced (Xiaodong, 2001). Further, feedback, an integral element of self-monitoring, has been shown to increase the effectiveness of self-monitoring by guiding students through tasks, delivering corrective feedback that helps the learner identify errors, and providing hints about how to correct the problem (Pintrich, 1995). In this study, the effects of self-monitoring with accuracy feedback and corrective feedback on math performance of fourth grade students were investigated. During a regular mathematics instruction period, the classroom teacher implemented the intervention. There were two experimental and one control groups. Randomly assigned participants (1) self-monitored math performance while receiving accuracy feedback; (2) self-monitored math performance while receiving corrective feedback; or (3) received no intervention. To determine whether self-monitoring (independent variable) resulted in higher student performance score in mathematics (dependent variable), baseline and intervention data and pretest and posttest data were compared. Although results of this study indicated that neither experimental group made gains in math performance as a result of intervention, results were inconclusive due to various factors, such as small sample size.

The Effects of Self-Monitoring with Accuracy Feedback versus Self-Monitoring
with Corrective Feedback on Students' Performance in Mathematics

The goal of education is to prepare children for self-sufficiency in adulthood. A large amount of this preparation involves learning the basic concepts of reading, writing, and arithmetic. However, since the conception of organized education, educators have had the challenge of working with students whose ability to learn the skills necessary for self-sufficiency in the classroom is impeded by a lack of basic learning strategies, poor instruction, or a learning disability. According to Ownby, Wallbrown, D'Atri, and Armstrong (as cited in Shapiro, Turco, Brown, & Cole, 1992), academic problems are the primary reasons that students are referred to school psychologists for evaluation. Further, the U.S. Department of Education (1999) indicated that more than 2.7 million students ages six to twenty one have been identified with a specific learning disability and are receiving services under the Individuals with Disabilities Education Act (IDEA). Even more surprising is that this statistic does not account for the hundreds of thousands of students who are not classified as having a learning disability, but still struggle with learning (i.e., slow learners) and do not receive special services. Therefore, the overarching purpose of this study was to assess the effectiveness of self-monitoring in improving mathematics performance of students in the regular education classroom.

A good number of struggling students specifically have difficulty with mathematics. According to Geary (2004), approximately 5% to 8% of school-aged children exhibit some form of Mathematics Learning Disability (MLD). MLD refers to children with low achievement scores in mathematics, relative to an average cognitive ability (Geary, 2004). Many of these children lack both the knowledge of arithmetic facts

and the problem solving skills that are important to be successful in math (Naglieri, 2003). According to Naglieri (2003), children who perform poorly in math may also do so because a potential weakness in a cognitive process called “planning,” which refers to the difficulty of applying appropriate or effective methods when problem solving (e.g., organization, reflection, analysis, and monitoring).

Geary (2004) outlined several specific problems that children who have difficulty with math may experience. For example, these students often use the same types of strategies (e.g., verbal counting) as normally achieving students. However, students who struggle with math continue to use these strategies at a later age than normally achieving students (Geary, 2004). In addition, students who struggle with math make more errors (e.g., counting errors) and use developmentally immature procedures (e.g., counting on fingers) more often when working out problems (Geary, 2004).

Resources are available regarding interventions to help struggling students work past these impediments to learning (Thomas & Grimes, 2002; Rathvon, 1999). However, as a result of the extensive variability in student ability, there is no clear-cut strategy for intervention. A review of the available research appears to suggest that self-monitoring with feedback is an intervention that may prove to be beneficial in serving students who struggle with mathematics in the classroom. For example, Naglieri (2003) asserts that there is research showing that children improve in math calculation when given cognitive strategy instruction such as self-monitoring.

Self-monitoring is an individual intervention program that is implemented in the classroom and refers to the personal and systematic application of behavior change strategies that result in the desired change in one’s own behavior (Sevier County Board of

monitoring, followed by Constructivists Theory (Jean Piaget), and Information Processing Theory.

Metacognition is most commonly defined as thinking about one's own thinking (Blakey & Spence, 1990). Metacognition has also been defined as the ability to understand and monitor one's own thoughts and the assumptions and implications of one's activities (Brown, Bransford, Ferrara, & Campione, 1983; Butterfield & Belmont, 1977; Flavell, 1979). More specifically, metacognition consists of three basic elements: developing a plan of action, maintaining or monitoring the plan, and evaluating the plan (North Central Regional Educational Laboratory, 1995). At each stage of the process, students should be asking specific questions that would help them understand the material (e.g., "What should I do first?" "What do I need to do if I do not understand?" And, "How well did I do?") (North Central Regional Educational Laboratory, 1995). Self-monitoring with feedback is just one component of the metacognitive process, specifically the evaluation component.

Self-monitoring serves as the cognitive mechanism that helps determine "what went wrong" or "what went right." For example, when a child self-monitors the accuracy of a math problem, he or she is evaluating whether the correct steps are being completed in order to get the correct answer. Questions that facilitate this evaluation process may be, "How well did I do?" and "What could have I done differently?" Although planning (i.e., thinking about what to do before one works a problem) and monitoring the plan (i.e., "Am I doing the right steps *now* to arrive at a correct answer?") are important steps in metacognition, the evaluation process is most relevant to this study, because it is the only step of the metacognitive process that can be explicitly monitored and measured.

Several researchers have developed theories to help explain the development of these mental processes and how they relate to children's learning. The most notable theories are that of constructivism and information processing. Constructivist Theory's most notable follower is Jean Piaget, who stressed the importance of cognitive development. Jean Piaget argued that we actively construct what we know of the world, but also that we organize this understanding in qualitatively different ways with age, each step resulting in a distinctly different stage of thought (Cobb, 2001). Piaget added that more complex stages of thought occur through time as a result of assimilation and accommodation, which are processes used to interpret new experiences in familiar ways or modify what we already know, respectively (Cobb, 2001). Piaget found that individuals' cognitive processes become more complex (and less concrete) as they grow older (Cobb, 2001). According to Grobecker (1999), self-regulation (i.e., self-monitoring) is a tool that facilitates this cognitive development. Grobecker (1999) argues that self-regulation exists as a result of the innate, biological need for mental structuring activity to resolve disequilibrium (i.e., not understanding new material). This assumption is consistent with Piaget's work that says, "...as children's organizing activity becomes increasingly more nested over time, their ability to engage in mental reflection over a sustained period of time and to consider the solution of another relative to one's own thinking also increases" (Piaget, 1987, p. 284). In other words, self-monitoring makes the transition between simple (concrete) to complex (abstract) thought occur more effortlessly.

Information Processing Theory, a more recent conceptualization of cognitive development, also emphasizes the importance of self-monitoring for learning.

Information processing theorists argue that the human mind is a symbol-manipulating system through which information flows (Berk, 1999). Unlike Constructivists, Information Processing theorists assume cognitive development as a more continuous process (Berk, 1999). These theorists claim that there are no stages of development, rather a progression on a continuum of the same processes (i.e., perception, attention, memory) (Berk, 1999). Information Processing theory states that higher cognitive functioning involves techniques of (a) questioning; (b) providing corrective feedback; (c) encouraging; (d) reflecting with the student; (e) setting goals; (f) discussing a rationale for learning; and (g) discussing transfer (Grobeck, 1999). Grobeck (1999) asserts that:

“Self-regulation skills additionally help students better determine what a given task is asking of them and to select the appropriate problem-solving sequence. Specifically, strategies are practiced for the purpose of making the student increasingly responsible for recruiting and applying the strategies effectively. As these skills improve, the learner can better monitor, evaluate and revise strategies while learning,” (p. 49).

Miller and Mercer (1997) assert that students who lack awareness of the skills, strategies, and resources necessary to perform tasks, and who fail to use self-regulatory mechanisms to complete tasks, have trouble with mathematics.

Keeping in mind the theories that underpin self-monitoring, what does the current literature show regarding the application of self-monitoring for improving students' academic performance? Research has suggested that self-monitoring is a type of metacognitive strategy and that it is effective in improving learning. According to

Zimmerman and Paulsen (1995), monitoring is an important component of self-regulated learning, which has been described by Brown, Bransford, Ferris, and Campione (1983) to be almost synonymous with metacognition. In addition, according to Xiaodong (2001), when students are engaged in metacognitive activities (e.g., self-assessment, self-explanation, *monitoring*, or revising), their learning is enhanced. Finally, within cooperative settings, students who were exposed to metacognitive training outperformed students who were exposed to worked-out examples on immediate and delayed post-tests (Mevarech & Kramarski, 2003).

Feedback, an integral element of self-monitoring, has been shown to increase the effectiveness of self-monitoring. During self-monitoring, when a student records his or her performance or behavior, he or she is being provided with feedback regarding the correctness or incorrectness of an answer or the absence or presence of a behavior. In essence, the student is receiving feedback about his or her performance or behavior. For example, when feedback is provided, the student is either reinforced for doing the problem correctly or is shown that the problem is wrong and needs to be fixed. Kahn (1989) explains this phenomenon by claiming that when a student is required to *evaluate* and *record* his or her behavior or performance, immediate feedback is provided, which offers internal or external reinforcement for an improvement in behavior or performance. According to Pintrich (1995), guiding students through tasks, delivering corrective feedback that helps the learner see where he or she has gone wrong, and providing hints about how to correct the problem can be very helpful.

In the literature, corrective feedback is labeled as a method that can be used to increase the accuracy of academic responses. In addition, self-evaluation (i.e., self-

monitoring) is described as one of several methods that provides corrective feedback (Skinner, Shapiro, Turco, Cole, & Brown, 1992). These authors also assert that students need to be provided with an example of the correct response so that they can self-evaluate their responses by matching their answers to the samples provided (Skinner, Shapiro, Turco, Cole, & Brown, 1992). According to Van Houten; Goldman & Pellegrino; and Siegler and Shrager (as cited in Skinner, Shapiro, Turco, Cole, & Brown, 1992), immediate corrective feedback works as follows:

When correct responses are made, this feedback [immediate corrective feedback] can serve as an immediate reinforcer. When responses are incorrect, immediate feedback prevents students from practicing incorrect responses and thereby decreases the probability that students will learn incorrect answers (p. 102).

Chappuis and Stiggins (2002) also illustrated the importance of feedback in, what they call, assessment for learning. These researchers explain that assessment for learning includes both student-involved assessment and effective teacher feedback. They described student-involved assessment as assessment information students use to manage their own learning. Chappuis and Stiggins (2002) went on to explain that this type of assessment helps students to understand how to learn best, plan, and take the next steps in their learning. To enhance student-involved assessment, Chappuis and Stiggins (2002) argue that teacher comments that focus on student work (i.e., describes why an answer is right or wrong in terms students can understand) and not on individual student characteristics (i.e., grades) can increase students' motivation and desire to learn. These researchers also claim that effective teacher feedback should guide students to better performance by explaining how the student arrived at an incorrect answer, rather than

simply labeling student errors or omissions. By doing this, Chappuis and Stiggins (2002) argue that, eventually, students will be able to direct their own learning. Chappuis and Stiggins claim was supported by Black and William (1998) who also found that classroom assessments that provide accurate, descriptive feedback to students and involve them in the assessment process can improve learning.

In general, it appears that self-monitoring forces the child to be aware of his or her own performance, therefore making him or her more likely to adjust that performance accordingly. The goal of self-monitoring is to shift supervision and control from the teacher to the student (Edelson, n.d.). The student has the opportunity to see his or her strengths and weaknesses as well as his or her progress. Using this strategy in the classroom not only benefits the struggling student, but also benefits the other students in the classroom by allowing the teacher to be more available for assistance (Cole & Bambara, 1992).

A large body of research has been conducted on self-monitoring with a diverse group of students (e.g., Learning Disabled, Emotionally Disordered, Behavior Disorder, and so on). According to Hallahan et al. (1981); Hallahan and Sapona (1983); Rooney, Hallahan, and Lloyd (1984), self-monitoring procedures have been used successfully with a range of exceptional students. The results of most studies have been favorable. For example, Lloyd, Bateman, Landrum, & Hallahan (1989) found that self-monitoring of both on-task behavior and academic productivity produced clear improvement in both on-task behavior and academic productivity. In addition, Harris (1986) found that both on-task behavior and academic response rate increased when using either method of self-monitoring (i.e., on-task behavior vs. academic response rate).

Research has also shown that many types of students are perfectly capable of effectively self-monitoring. Some skepticism has arisen in the past about whether children who have difficulty in the classroom even have the cognitive skills necessary to successfully implement self-monitoring as a means of changing behavior. Can students evaluate and record their behaviors as accurately as an objective observer would? Carr & Punzo (1993) found that students were very accurate in their self-recording. However, O'Leary & Dubey (as cited in Harris, 1986) determined that the accuracy of self-monitoring is frequently unnecessary in order to achieve desirable effects. Other researchers have also determined that students classified as learning disabled can successfully implement self-monitoring procedures in special and regular education settings and improve their behavior accordingly (Prater, Joy, Chilman, Temple, & Miller, 1991).

When choosing self-monitoring as an intervention, most people choose to target one of the following behaviors: on-task behavior, academic productivity, or academic accuracy. A target behavior is selected according to a student's target problem. For example, if a student has difficulty staying on-task (i.e., out of seat behavior or talking to peers) during class time, it would be appropriate for that child to self-monitor his or her on-task behavior. When self-monitoring on-task behavior, the student asks himself or herself, "Am I paying attention," when prompted, and then records that evaluation as either "yes" or "no" on a note card (Prater, Joy, Chilman, Temple, & Miller, 1991). When self-monitoring academic productivity, the student counts and records how many problems he or she has completed during a specified interval, and then records that frequency on either a graph or a note card (Carr & Punzo, 1993). When self-monitoring

academic accuracy, the student counts and records how many problems he or she has *correctly* completed in a specified interval (Carr & Punzo, 1993).

How effectively does self-monitoring academic accuracy improve academic performance? The current research appears to be positive. For example, Carr & Punzo (1993) discovered that when students self-monitored academic accuracy, gains in accuracy as well as on-task behavior and productivity were found. In another study, Lam and Cole (1994) found that the most beneficial self-monitoring procedure used was self-monitoring academic accuracy. They noted that this procedure not only resulted in increased academic accuracy, but also impacted positively on on-task and disruptive behaviors.

Statement of the Problem

As mentioned previously, the U.S. Department of Education (1999) indicated that thousands of students struggle with learning. Many researchers and organizations (e.g., National Council of Teachers of Mathematics) argue that students' difficulty in mathematics may be attributable to procedural-focused instruction rather than conceptual-focused instruction (Grobeck, 1999). For example, the National Council of Teachers of Mathematics (1991) asserts that teachers should de-emphasize explicitly taught skills and strategies and encourage the expansion of children's logical thinking.

Some researchers contend that techniques outlined by the National Council of Teachers of Mathematics could enhance and facilitate mathematics learning (Giordana, 1993; Hutchinson, 1993; Mercer, Harris, & Miller, 1993). According to Grobeck (1999), one of these techniques is self-regulation (e.g., self-monitoring). Specifically, Grobeck explains that self-regulation is an innate, biological need for mental re-

structuring (i.e., learning new material by reorganizing what one already knows) that can enhance learning if used properly. However, students may not have attained the skills necessary to self-regulate (Geary, 2004). Teaching students how to use self-regulation skills may prove to enhance students learning and improve their academic performance. Further, there is limited research that examined the effectiveness of corrective feedback on math accuracy.

Based on the supportive research indicating that self-monitoring and corrective feedback are effective in changing behavior and performance, this study was extended and set out to determine whether self-monitoring with feedback (written corrective feedback vs. accuracy feedback) would improve students' mathematics accuracy. Accordingly, the current study attempted to answer two questions: (1) Would self-monitoring with accuracy feedback and self-monitoring with corrective feedback improve students' math accuracy?; and if so, (2) Would self-monitoring with corrective feedback result in a higher increase in math accuracy compared to self-monitoring with accuracy feedback?

It was hypothesized that both self-monitoring with accuracy feedback and self-monitoring with corrective feedback would improve students' math accuracy. In addition, it was further hypothesized that self-monitoring with corrective feedback would result in a higher increase in math accuracy compared to self-monitoring with only accuracy feedback. According to available research, it appears that delivering corrective feedback (showing the specific steps) helps a learner see where he or she has gone wrong and helps him or her avoid the possibility of unknowingly completing a math problem incorrectly. Simply telling the student that he or she is either correct or incorrect (i.e.,

accuracy feedback) does not explain why he or she is correct or incorrect. In other words, it does not encourage the student to think metacognitively. Corrective feedback works better in explaining to the student why he or she was incorrect (Pintrich, 1995). According to Scheid (as cited in Naglieri, 2003), "When children perform poorly in math calculation because of poor organization, inadequate reflection on the procedures used, difficulty analyzing the demands of the problem, and failure to carefully monitor the work, then cognitive strategy instruction [such as self-monitoring] is necessary."

Method

Participants

Participants included 12 students from a 4th grade classroom in a rural community in Indiana. Students from this grade were considered to be ideal participants for this study, because children of this age seem to be developmentally better equipped to successfully carry out the self-monitoring intervention. Participants were 5 boys and 7 girls all aged 10 or 11 years old. The majority of participants (n=9) were Caucasian and the remaining three participants were African-American, Asian, and Bi-racial. Almost all participants (n=10) were ineligible for special education under any category. Two students received special education services (i.e., Speech Therapy and Learning Disability). Students were randomly assigned to one of three groups: self-monitoring with accuracy feedback (n=5), self-monitoring with corrective feedback (n=4), and control group (n=3). When random assignment was conducted before intervention, 5 to 6 students were in each group. However, because of attrition due to moving out of the school district and one student receiving special education services in math outside of the classroom, the number of participants in the self-monitoring and control groups decreased. Participation was contingent upon parental consent, and it was confidential and voluntary.

Materials

Self-Monitoring Sheets: Self-monitoring sheets were provided to each student in both experimental conditions (i.e., self monitoring with accuracy and self-monitoring with corrective feedback). For each math problem, these sheets included the question,

“Did I get the problem right?” This was followed by the words “YES” and “NO”, so that the participants could circle whether they got each problem correct or incorrect. Self-monitoring sheets also included a reminder to the students in the self-monitoring with corrective feedback group to refer to the appropriate feedback sheet if they worked the problem out incorrectly. In this study self-monitoring of academic accuracy refers to the process by which a student assesses his or her own accuracy by counting up the number of correctly completed items and then recording the frequency of accurate responses on a record form. A sample of the self-monitoring sheet, is presented in Appendix A.

Feedback Sheets: Answer keys (i.e., “Feedback Sheets”) were provided for those participants in the experimental groups. In this study, accuracy feedback was defined as feedback about a math problem by simply stating the correct answer. In contrast, corrective feedback was defined as feedback about a math problem that states the correct answer to the math problem as well as provides a written out example of the correct steps and correct answer for the problem.

For participants in the self-monitoring with accuracy feedback condition, the feedback sheets included the correct answers to each math problem in a lesson. For participants in the self-monitoring with corrective feedback condition, the feedback sheets included (1) the correct answers to each math problem in a lesson and (2) solutions for each problem that explained each step required to arrive at a correct answer. Each group was provided with a feedback sheet customized by the researcher to the confines of their experimental group (i.e., accuracy versus corrective feedback). To ensure that the feedback sheets were being constructed accurately, the teacher reviewed its contents

before using them in the experiment. As mentioned previously, the experimenter obtained data on math accuracy by scoring the participants' completed activity. The details of the construction of the feedback sheets are discussed under the "*Teacher's Manual*" section below. For a sample of a feedback sheet, please refer to Appendix B.

Teacher's Manual: The teacher's manual was used to create the participants' feedback sheets (i.e., answer keys). The teacher's manual is a book that outlines the math curriculum for the teacher. It included pages from the students' textbooks, sample tests, quizzes, and practice problems, correct answers for tests, quizzes, and practice problems, lesson outlines, tips for instruction, and so on. This manual also included "check problems" for each math lesson presented in the curriculum as well as the correct answers to these problems. These "check problems" consisted of approximately 5 to 12 problems directly related to a particular lesson and are typically used to help students practice their new skills (e.g., Lesson 3.1 – Multiplying by 10, 11, and 12).

Although the teacher's manual was used to create feedback sheets by using the "check problems" answer key, the solutions to the problems were not explicitly available in the teacher's manual. Therefore, for students in the self-monitoring with corrective feedback group, the researcher produced appropriate solutions to each problem based on the lesson provided in the manual. In other words, the researcher made the solutions to the problems as close as possible to the procedures outlined in the teacher's manual. In addition, to ensure that the feedback sheets were accurate, they were constructed in consultation with the teacher; that is, the teacher reviewed the contents. For a complete reference of the teacher's manual, please refer to the "References" section of this paper.

Procedure

Recruiting: In order to conduct this research, a school was identified, based on convenient proximity, and permission was sought. After obtaining approval from the school principal, the researcher sent a mass e-mail to all 4th, 5th, and 6th grade teachers asking them to participate in the study by volunteering their classrooms. The e-mail consisted of a short explanation of the purpose and procedures of the study. Approximately three teachers responded to the e-mail stating their interest to participate. The researcher then chose the teacher that would be most appropriate for the study based on class size, content and structure of math instruction, and grade level.

Planning: Before implementing the intervention, the researcher explained to the teacher the purpose of the study and the procedures that needed to be followed in more detail. During this discussion, the teacher and researcher identified concerns that may have created any confusion for the students and interfered with the “flow” of instruction. Modifications based on these concerns were made as a result. For example, the teacher was concerned about whether any students would cheat if a student had feedback sheets in his or her possession while completing the “check problems.” Therefore, instead, the feedback sheets were posted on the wall where students could go to monitor their performance *after* they had completed their check problems.

Consent and Random Assignment: After planning, a consent form (Appendix C) was sent to all parents of children in the classroom via U.S. Mail. The form informed parents that their child’s participation was voluntary and confidential. Once signed consent forms were received, the researcher conducted a random assignment for the experimental and control groups. In order to give each participant an equal chance, the

researcher put each participant's name on a small piece of paper and randomly picked names for each group. Then, the teacher was given a list of which students were in what groups.

Pre-test

Prior to implementation of the intervention, a 17- item pretest was given to the students that included math problems similar to what they learned prior to and during the intervention. The teacher agreed to closely follow the math curriculum as the teacher's manual suggested (i.e., Chapter 1, 2, 3, 4, ...), so that the content of the pretest and posttest was based on the teacher's plan for the year. Problems on the pretest and posttest included those which touched on concepts that were presented in previous math lessons. Specifically, the pretest was a cumulative review for chapters 1 through 4 (Appendix D). The students finished chapters 1 and 2 before the intervention and planned on completing lessons through chapter 4 by the end of the year, thus making the cumulative review test for chapters 1-4 appropriate for pretest and posttest use.

Baseline

Baseline data were collected over a five-week period. The researcher collected baseline data every day students were asked to do an in-class math assignment (these assignments were called "check problems"). On average, students were asked to complete "check problems" approximately three times per week. No intervention was implemented or used during this time.

Training

Participants were trained in how to self-monitor their math accuracy after baseline and prior to implementing the intervention. This time line was chosen to encourage

recall of correct self-monitoring procedures by participants during the intervention. The researcher completed this training during one five to 10-minute session or until the students mastered the procedure. Training included an explanation of accuracy (i.e., correct answers) and self-monitoring. In addition, after a brief explanation of the procedure, the researcher demonstrated the procedure, and one participant volunteered to demonstrate the procedure with the researcher for the rest of the group. In a question and answer format, the participant and the researcher covered the correct steps of the procedure and also reviewed when to use appropriate forms. For an outline of topics presented in participant training, please refer to Appendix E, which shows a sample of the training objectives. Participants were instructed not to ask the teacher for help. Doing so eliminated possible inflation in accuracy that was not due to the intervention alone. Check problems were not used for a grade by the classroom teacher, therefore, avoiding any problems this may have created for the students academically.

Intervention

All participants in the study, except those in the control group, participated in the intervention phase. Two interventions were implemented: (1) Self-monitoring with accuracy feedback only and (2) Self-monitoring with corrective feedback. The intervention phase lasted eight consecutive weeks, and students completed "check problems" approximately 2 to 3 times per week.

Students were asked to complete "check problems" in class for approximately ten to twenty minutes. The exact content of the check problems included problems pertaining to addition (e.g., $344 + 123 = ?$), subtraction with regrouping (e.g., $912 - 784 = ?$), multiplication facts (e.g., $9 \times 9 = 81$), simple division (e.g., $12 \div 3 = 4$), and problems

requiring the application of these concepts (e.g., "Sarah has 3 boxes with 4 pencils in each box. How many pencils does she have all together?"). The step by step self-monitoring procedure for each group was as follows:

Self-Monitoring with Accuracy Feedback Group. At the teacher's request, students were asked to complete "check problems" for the math lesson that had been reviewed that day during lecture. After the participants in this group completed their "check problems", they were instructed to review the feedback sheets (i.e., answers only) appropriate for their assigned group. The feedback sheets were taped on a wall in the classroom. Participants were instructed to (1) check the accuracy of their answers with the correct answers on the feedback sheet (accuracy = participants' answer matched the answer given on the feedback sheet); (2) count up the number of problems they answered correctly; (3) record the number of problems they answered correctly (i.e., "I got ____ out of ____ problems correct.") on their self-monitoring sheet; and (4) return the self-monitoring sheet to the teacher. When checking the accuracy of their performance, students were given a prompt on their self-monitoring sheet asking, "Did I get the problem right?" If so, they were to circle "YES" on the self-monitoring sheet. If their answers were incorrect in comparison to the feedback sheet, they were to circle "NO" on the self-monitoring sheet. This procedure was completed for each "check problem."

Self-Monitoring with Corrective Feedback Group. Like participants in the self-monitoring with accuracy feedback group, participants in this group were also asked to complete "check problems" for the math lesson that had been reviewed that day during lecture. After the participants in this group completed their "check problems", they were also instructed to review the feedback sheets (i.e., answers and worked out solutions to

each problem) appropriate for their group. Feedback sheets for this group were also taped on the wall for participant use. Participants were instructed to conduct the exact procedure as the participants in the self-monitoring with accuracy feedback group. Just as the first group, these participants were asked to check the accuracy of the problems they completed with the feedback sheets, count up and record how many problems they got correct on the self-monitoring sheet, and return the self-monitoring sheets to the teacher. However, in contrast to students in the self-monitoring with accuracy group, students in this group had a different self-monitoring sheet reminding them to review the correct *solution* to each problem that was incorrect in comparison to the feedback sheet. So, if a student worked a problem incorrectly, he was to circle "NO" on the self-monitoring sheet and then review the correct solution to the problem on the feedback sheet.

Control Group. The control group did not self-monitor or receive feedback, but rather completed the same check problems as those in the treatment groups.

Finally, when all participants completed a "check problem" set, the teacher collected each student's "check problems", each student's self-monitoring sheet, and the feedback sheet for each experimental group. The teacher immediately sent these materials to the researcher, who then reviewed the material and entered the data in Microsoft Excel data management program.

Treatment Integrity

To ensure that the intervention was being implemented with integrity, the researcher observed the participants (including the teacher) while they were conducting the procedure on the first day and a few weeks into the intervention phase. Specifically,

the purpose of these observations was to see whether the students reviewed the appropriate feedback sheet after completing their check problems, recorded their performance on their self-monitoring sheets, and whether the teacher provided the appropriate directives. With the exception of a few minor problems (e.g., students asking the teacher what to do next) on the first day of implementation, the students appeared to be conducting each step as intended.

Posttest

After the intervention was completed, a posttest (Appendix D) was given to all students. The posttest was identical to the pretest discussed earlier.

Results

The effect of the independent variable (self-monitoring) was measured by the participants' math accuracy score (dependent variable) on the pretest versus posttest and baseline versus intervention. Pretest and posttest performance, as measured by the number of problems answered correctly, was compared for each group and each participant. Baseline and intervention performance, as measured by the percentage of problems answered correctly, was also compared for each group.

Table 1 presents the means and standard deviations for math accuracy (for the pretest and posttest) for the experimental and control groups. As a whole, no group performed better during or after implementation of the intervention. Scores on the posttest did not increase compared to the pretest. In other words, no pattern was found that would indicate that the intervention(s) improved students' math accuracy. In fact, the control group showed the most gains from pretest to posttest, with a mean increase of 1.67.

When looking at the mean math accuracy during intervention, the control group answered more problems correctly (64.33) than both the self-monitoring with accuracy feedback group (14.73) and self-monitoring with corrective feedback group (21.08).

The mean percentage of problems answered correctly for baseline and intervention for all three groups is presented in Figure 1. As illustrated, none of the groups made higher gains in math accuracy from baseline to intervention. In fact, each group's percentage of problems answered correctly decreased from baseline to intervention, with the smallest decreased realized by the control group. Results from this

source also suggest that no pattern was found that would indicate that the intervention(s) improved students' math accuracy.

Figures 2, 3, and 4 show the number of problems answered correctly for each participant in each group for pretest and posttest. As evidenced in these figures, no student in any group answered more problems on the posttest in comparison to the pretest. This again suggests that neither intervention improved any participant's math accuracy.

Discussion

The purpose of this study was to determine whether self-monitoring with feedback would improve students' performance in math. It was hypothesized that both self-monitoring with accuracy feedback and self-monitoring with corrective feedback would improve students' math accuracy. In addition, it was hypothesized that self-monitoring with corrective feedback would result in a higher increase in math accuracy compared to self-monitoring with only accuracy feedback.

Due to the complexities of the method, small sample size, and the constraints of the classroom, results from descriptive statistics and graphical analysis were inconclusive. However, the data indicated that participants, in all groups, did not show increased math accuracy. In other words, neither intervention (i.e., self-monitoring with accuracy feedback and self-monitoring with corrective feedback) appeared to produce an increase in participants' math accuracy on pretest versus posttest or baseline versus intervention. Therefore, it is unclear whether the hypotheses or the study were supported. In addition, self-monitoring with corrective feedback did not appear to result in a higher increase in math accuracy compared to self-monitoring with only accuracy feedback. Taking the small sample size into consideration, results of this study seem to be inconsistent with current research that suggests that self-monitoring has been shown to improve learning for a diverse group of students (Xiaodong, 2001; Prater, Joy, Chilman, Temple, & Miller, 1991; Carr & Punzo, 1993) and that feedback, an essential component of self-monitoring, has also been shown to improve students' learning and cognitive strategy use (Pintrich, 1995; Chappuis & Stiggins, 2002; Black & William, 1998).

Again, keeping in mind the small sample size, the results of this study raise several questions for future research and teacher instruction. First, is providing specific, step by step feedback on mathematics homework assignments, quizzes, and tests effective in increasing students' math accuracy as the available research suggests? Research has shown that guiding students through tasks, delivering corrective feedback that helps the learner see where he or she has gone wrong, and providing hints about how to correct the problem can be very helpful (Pintrich, 1995). Secondly, is one type of feedback more effective than another in increasing math performance? Black and William's (1998) found that classroom assessments that provide accurate, descriptive feedback to students and involve them in the assessment process can improve learning. However, results from this study suggest that the more specific types of feedback (e.g., feedback including step by step correct answers) may not improve the already favorable effects of self-monitoring. In this study, the math performance of participants in the self-monitoring with accuracy group was similar to those in the self-monitoring with feedback group.

Also, this trend may raise another question, that is, is self-monitoring with corrective feedback an effective method to help encourage independent learning? According to Grobecker (1999), "Self-regulation skills additionally help students better determine what a given task is asking of them and to select the appropriate problem-solving sequence" (p. 49). Based on Grobecker's research, self-monitoring may facilitate better cognitive strategy use, thus making independent learning a better possibility. It appears participants did not learn to work independently during this study. Although participants in the experimental group were trained not to ask the teacher for help; during

the first day of intervention they frequently asked for help or what to do next. Many students need intensive one on one instruction when practicing new skills; therefore, providing only written corrective feedback may not be useful in improving students' independent and thoughtful learning.

It appears there were multiple factors that might have influenced the outcome of this study. First, the sample size used for this study was too small to make inferences about the actual effects of self-monitoring with feedback. Secondly, participants might not have been closely monitored by the teacher to ensure that each step of the intervention was being completed as intended. Although students were trained how to self-monitor, it is possible that some of the participants did not fully understand each step of the intervention, and, therefore, completed the task as they saw fit. Research shows, however, that students of this age are perfectly capable of self-monitoring (Carr & Punzo, 1993; Prater, Joy, Chilman, Temple, & Miller, 1991).

In addition, there may have not been ample time each day to complete the intervention as planned. Often, teachers have a specific amount of instructional time that is allocated to each subject area. Participants may not have had sufficient time to complete their assignments, check and record their accuracy, and review solutions to each problem. However, it is important to note that to assure treatment integrity, the classroom teacher, who implemented the intervention, was consulted and involved during the design phase of the study. This was crucial because research has demonstrated the importance of treatment acceptability, or the extent to which the consultee perceives the proposed treatment to be appropriate, fair, reasonable, and intrusive (Watson, Sterling, McDade, 1977). For example, according to Reimers et al. (as cited in Stoiber & Kratochwill,

1998), the acceptability of an intervention relates to implementation by clients and to eventual outcomes.

Another factor that may have affected the results was the content and construction of the feedback sheets. On several check problems, there were many variations of the correct answer. Most of the check problems involved objective answers (e.g., $1 + 1 = 2$). However, at least one problem in each set required the application of math concepts in sentence form (e.g., "Write a multiplication sentence about this table"). The correct answer required that a specific concept be addressed, but that concept could be addressed in several different ways. For instance, there could be several possible correct answers for the question, "Write a division sentence for Table 1" due to the variability of the data in the table. This may have created some confusion where students may have interpreted their answers as being incorrect in comparison to the feedback sheets when, in fact, their answers were correct. If participants were unsure of the accuracy of their answers, they would more than likely be unable to accurately self monitor their performance. Although the researcher attempted to reduce this problem by double checking and rescoring the problems the students completed, subjectivity was still involved in grading and it may have affected the results. Research suggests that feedback be accurate and descriptive (Black & William, 1998). The feedback provided in this experiment may not have been as accurate as the teacher's manual and as the teacher intended, thus, resulting in potential problems.

Also, a potentially problematic element to the feedback sheets (especially for the self-monitoring with corrective feedback group) may have been the construction of corrective solutions to math problems. Often, when a student completes a problem

incorrectly, he or she is given a verbal explanation of what went wrong. In this study, however, the explanation of how to compute the problem correctly was in written form. As a result of math being a very abstract concept, especially for elementary school students, explaining solutions in written form can become quite complex. Participants may have had difficulty understanding the explanations of the problem solutions due to their complexity. Therefore, the intervention could have become counterproductive, additionally confusing the students instead of assisting them. In addition to being more complex, the solutions on the feedback sheets may have been different from the teacher's instructions. In other words, because there are various ways of explaining a math problem, the teacher may have taught the students several different methods while the written feedback gave only one solution, which could have resulted in confusion.

In addition to a larger sample size, future studies may benefit from more standardized procedures for producing the feedback sheets. As discussed elsewhere, because of the current curriculum which did not explicitly provide solutions, the researcher was required to develop solutions for each check problem set based on the manual's lesson description. These solutions may have deviated from the curriculum's intent to explain how problems should be solved, thus potentially affecting the results of the study. Having the teacher give verbal feedback in addition to written feedback might minimize this problem. This would also control for any effects that poor reading or comprehension would pose for some students. Secondly, choosing math problems that can be objectively scored (e.g., $1 + 1 = 2$) may have lessened any confusion. By having objective math problems, the subjectivity in scoring the items would be reduced.

Reducing scoring subjectivity is always an important factor in any research design (Elmes, Kantowitz, & Roediger, 1999).

The implication of this study is that more research is needed in the area of self-monitoring with feedback for increasing math accuracy. Although the results of this study are inconclusive, the current literature suggests that self-monitoring enhances learning as assessed by academic accuracy, and also results in independent learning. If future studies that use a larger and more diverse sample size obtain more favorable conclusions and support the utility of self-monitoring in the classroom (and not only in controlled one to one or small group environment), potentially, both students and teachers benefit. Most students in a typical classroom may learn more effectively and work independently, freeing teachers to help severely struggling students or to provide more invaluable instructions.

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Appendix A

Self-Monitoring Sheet (Corrective Feedback Group)

Problem #1

Did I get the problem right? YES NO

If you got the problem wrong, review the solution to the problem on the Answer and Solution Sheet.

Problem #2

Did I get the problem right? YES NO

If you got the problem wrong, review the solution to the problem on the Answer and Solution Sheet.

Problem #3

Did I get the problem right? YES NO

If you got the problem wrong, review the solution to the problem on the Answer and Solution Sheet.

Problem #4

Did I get the problem right? YES NO

If you got the problem wrong, review the solution to the problem on the Answer and Solution Sheet.

Problem #5

Did I get the problem right? YES NO

If you got the problem wrong, review the solution to the problem on the Answer and Solution Sheet.

I GOT _____ OUT OF _____ PROBLEMS RIGHT.

Appendix A

Self-Monitoring Sheet (Accuracy Feedback Group)

Problem #1

Did I get the problem right? YES NO

Problem #2

Did I get the problem right? YES NO

Problem #3

Did I get the problem right? YES NO

Problem #4

Did I get the problem right? YES NO

Problem #5

Did I get the problem right? YES NO

I GOT _____ OUT OF _____ PROBLEMS RIGHT.

Appendix B

Sample of Feedback Sheet (Accuracy Group)

CHECK

For another example, see Set 3-9 on p. 182.

1. $0 \div 8$

2. $5 \div 5$

3. $3 \div 1$

4. $0 \div 6$

5. $1 \div 1$

6. **Number Sense. Can you put 4 counters into zero rows? Explain****ANSWERS**

1. 0

2. 1

3. 3

4. 0

5. 1

6. No, because there is no place to put the counters.

Appendix B

Sample Feedback Sheet (Corrective Feedback)

CHECK

For another example, see Set 3-9 on p. 182.

-
1. $0 \div 8$ 2. $5 \div 5$ 3. $3 \div 1$ 4. $0 \div 6$ 5. $1 \div 1$

6. **Number Sense. Can you put 4 counters into zero rows? Explain**
-

ANSWERS and SOLUTIONS

1. **Answer – 0**
Solution – $0 \div 8 = 0$, because zero divided by any number (except 0) equals zero.
2. **Answer – 1**
Solution - $5 \div 5 = 1$, because any number divided by itself (except 0) equals one.
3. **Answer – 3**
Solution - $3 \div 1 = 3$, because any number divided by one is that number.
4. **Answer – 0**
Solution - $0 \div 6 = 0$, because zero divided by any number (except 0) equals zero.
5. **Answer – 1**
Solution - $1 \div 1 = 1$, because any number divided by itself (except 0) equals 1.
OR any number divided by one is that number.
6. **Answer – No**
Solution – Because there is no place to put the counters.

Appendix C

Consent Form

December 10, 2004

To the Parents of: _____

Dear Parents or Guardians:

Hello. My name is Kristy Baker, School Psychologist Intern for the Community Schools of Frankfort. As part of my internship, I am required to complete a thesis project. A thesis project is a way for graduate students to conduct their own research experiment on a topic of their choosing.

I have arranged with your child's teacher to begin my thesis project after Christmas break. The topic that I have chosen to research relates to elementary school students' achievement in math. The goal of my project is to determine whether student self-monitoring will increase math achievement (i.e., Increase the percentage of problems worked out correctly). Self-monitoring refers to the process of evaluating one's work (i.e., math work) and recording whether the work is accurate. More specifically, I have the goal of determining whether different types of feedback (e.g., Informing of correctness or incorrectness vs. Informing of correctness or incorrectness plus a written out example of correct problem solution) will produce a greater increase in students' accuracy in mathematics.

In order to complete this research project, the teacher and I will be arranging her math lessons as follows:

- Teacher will present the new math lesson for the day. No changes will be made in math instruction.
- Students will then be asked to complete an in class assignment that requires them to utilize the skill taught on a particular day.
- When completing the in class math assignment, each student will be asked to monitor how accurate his or her answers are by checking their answers with an answer sheet and evaluating whether he or she answered the problem correctly.
- When the whole assignment is completed, the student will count up and record how many total problems he or she got correct. *This score will NOT be used in calculation of your child's final grade.*
- The in-class assignment will then be collected and sent to me for data collection. These assignments will not be sent home with your child.
- The students will take a pre-test of math skills before the intervention is implemented and a post-test after the intervention is implemented. *Neither test will be taken for a grade. In-class work during math will also NOT be taken for a grade.* These measures will simply be used as data for the research project.

Please note that no changes will be made to your child's math instruction. In addition, only a few minor changes (e.g., students will be monitoring their performance) will be made to your child's in-class work during math. This project will not affect your child's grade in any way.

If you give permission for your child to participate in this research project, please provide your written consent on the attached form. **Please send this signed form with your child to school by December 17, 2004.**

If you have any questions regarding this information, please contact Kristy Baker at (765) 654-8545, Extension 137 or e-mail her at bakerk@frankfort.k12.in.us.

Sincerely,

Kristy Baker, School Psychologist Intern
Boone-Clinton Northwest Hendricks Joint Services

Consent For Participation in Research Project

I give permission for my child, _____, to participate in Kristy Baker's research project.

I DO NOT give permission for my child, _____, to participate in Kristy Baker's research project.

Appendix D

Pretest and Posttest



Chapters 1–4

Cumulative Review and Test Prep

Indiana Standards 1 and 2

Number and Operation

MULTIPLE CHOICE

- Eagle Creek Park near Indianapolis has 1,400 acres of water and 3,900 acres of dry land. How many MORE acres are there of dry land than water?
A 3,900 C 5,300
 B 2,500 D 1,500
- The Moon is 238,857 miles from Earth. What is the place value of the 3 in this number?
A tens
B hundreds
C thousands
 D ten thousands
- Which expression is another way to write $3 + 3 + 3 + 3$?
A 3×3 C $3 + 4$
B $4 + 3$ D 3×4
- Martin State Forest has 7,023 acres and Clark State Forest has 23,979 acres. ESTIMATE to find the total number of acres.
 A 31,000 C 29,000
B 30,000 D 20,000

CONSTRUCTED RESPONSE


- Write a number sentence using the numbers 28, 4, and 7. Then write all of the number sentences in the same fact family.

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Indiana Standards 4 and 5

Geometry and Measurement

MULTIPLE CHOICE

- If a square measures 10 feet on one side, what is the perimeter of the square?
A 10 ft C 40 ft
B 20 ft D 100 ft
- Identify this figure.

A trapezoid C rhombus
B triangle D square
- A camper bought some trail mix that cost \$1.84. She paid the clerk with a \$5 bill. Which shows the least number of coins and bills the camper will receive in change?
A four \$1 bills, 2 dimes, 1 penny
B three \$1 bills, 2 dimes, 1 penny
C three \$1 bills, 3 nickels, 1 penny
 D three \$1 bills, 1 dime, 1 nickel, 1 penny

CONSTRUCTED RESPONSE

-  Use your ruler to solve this problem. Measure the paper clip twice. First measure it to the nearest $\frac{1}{2}$ inch. Then measure it to the nearest $\frac{1}{4}$ inch. Explain why these measurements are different.



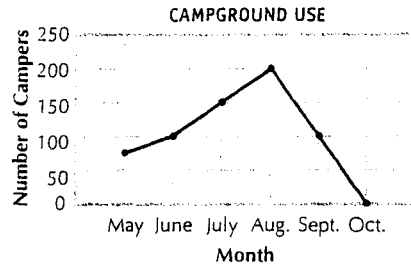
See margin.

Indiana Standard 6

Data Analysis and Probability

MULTIPLE CHOICE

Use the line graph for 10 and 11.



10. In which month was the campground used the MOST?
 A June C August
 B July D September
11. How many FEWER campers used the campground in May than in August?
 A 25 C 150
 B 125 D 275

CONSTRUCTED RESPONSE

12. Samantha took a survey. She asked some students how many pets they had. She recorded the results in a tally chart.

Number of Pets	Number of Students
0	
1	
2	
3	
4	I

Display the data from the tally chart on a line plot. Then describe any patterns that you see in the data using the words "most," "few," and "none."
 See margin.

Indiana Standard 3

Algebra

MULTIPLE CHOICE



13. A park ranger sells daily permits that cost \$4 each. Which expression models the TOTAL amount of money the park ranger collects?
 A $4 + x$ C $4 - x$
 B $4 \times x$ D $4 \div x$
14. Use the formula $y = x \div 8$ to find the value of y when $x = 56$.
 A $y = 7$ C $y = 48$
 B $y = 8$ D $y = 64$
15. What is the next number in the pattern?
 4, 8, 16, 32, 64, ?
 A 96 C 124
 B 98 D 128
16. Suppose you have 24 apple slices. You and 3 friends will share the slices. Which number sentence shows how many slices each person will get?
 A $24 - 3 = 21$
 B $24 \div 3 = 8$
 C $24 \div 4 = 6$
 D $24 + 3 = 27$

CONSTRUCTED RESPONSE

17. How can you use addition to solve a multiplication problem? Show your method by finding 8×4 .
 See margin.

Appendix E

Outline for Participant Training

Introduction

- I am doing a project. Kind of like a science experiment.
- You are going to help me do it.
- In my project, I am trying to figure out how you learn best.
- And to do that, I am going to change how you do your math assignments.

Group: Self-Monitoring with Answers and Solutions

- Teacher will ask you to do the check problems at the end of some lessons.
- You will complete those problems at your desk.
 - When you have finished, the teacher will ask you to come to her desk so you can check your answers.
 - Teacher will have an “Answer and Solution” sheet at her desk so you can check your work.
- You will also be given a “self-monitoring” sheet. This sheet will ask you “Did I get the problem right?” for every problem in your assignment.
- You are to check the answer on the teacher’s “Answer and Solution” sheet and see if you got the problem correct.
 - If you did, circle YES, and check the next problem.
 - If you didn’t, circle NO and read over the solution that is on the sheet.
- Do this for all problems.
- At the end, count how many you got correct.

Group: Self-Monitoring with Answers Only

- Teacher will ask you to do the check problems at the end of some lessons.
- You will complete those problems at your desk.
 - When you have finished, the teacher will ask you to come to her desk so you can check your answers.
 - Teacher will have an “Answer” sheet at her desk so you can check your work.
- You will also be given a “self-monitoring” sheet. This sheet will ask you “Did I get the problem right?” for every problem in your assignment.
- You are to check the answer on teacher’s “Answer and Solution” sheet and see if you got the problem correct.
 - If you did, circle YES, and check the next problem.
 - If you didn’t, circle NO
- Do this for all problems.
- At the end, count how many you got correct.

Things to Remember

- Have someone repeat back procedure.
- This is not for a grade!!!!
- BE HONEST – It is ok if you get some wrong. Saying you got some right when you actually got some wrong will change the results of my project and not really tell me how you learn.
- Keeping track of how many you get right is just to tell me how you learn, not whether you are good at math.

Table 1

Mean Pretest and Posttest and Intervention Math Accuracy Scores for the Sample

Group	N	M	SD
		Pretest/Posttest	
Accuracy	5	10.8/10.6	2.39/1.82
Corrective Feedback	4	8.75/9.00	1.5/2.31
Control	3	13.00/14.67	1.0/0.58
		Intervention	
Accuracy	5	49.6	9.34
Corrective Feedback	4	43.25	9.00
Control	3	64.33	1.53

Figure 1. Percentage of problems answered correctly for baseline versus intervention.

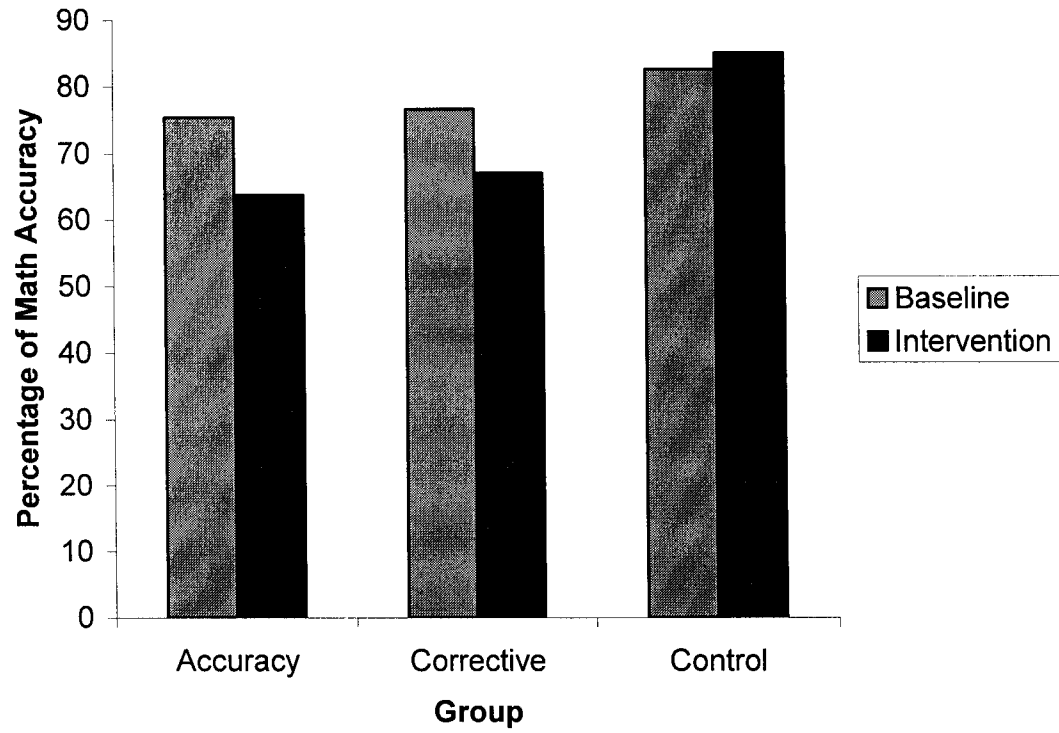


Figure 2. Number of problems answered correctly on Pretest and Posttest for Self-Monitoring with Accuracy Feedback group.

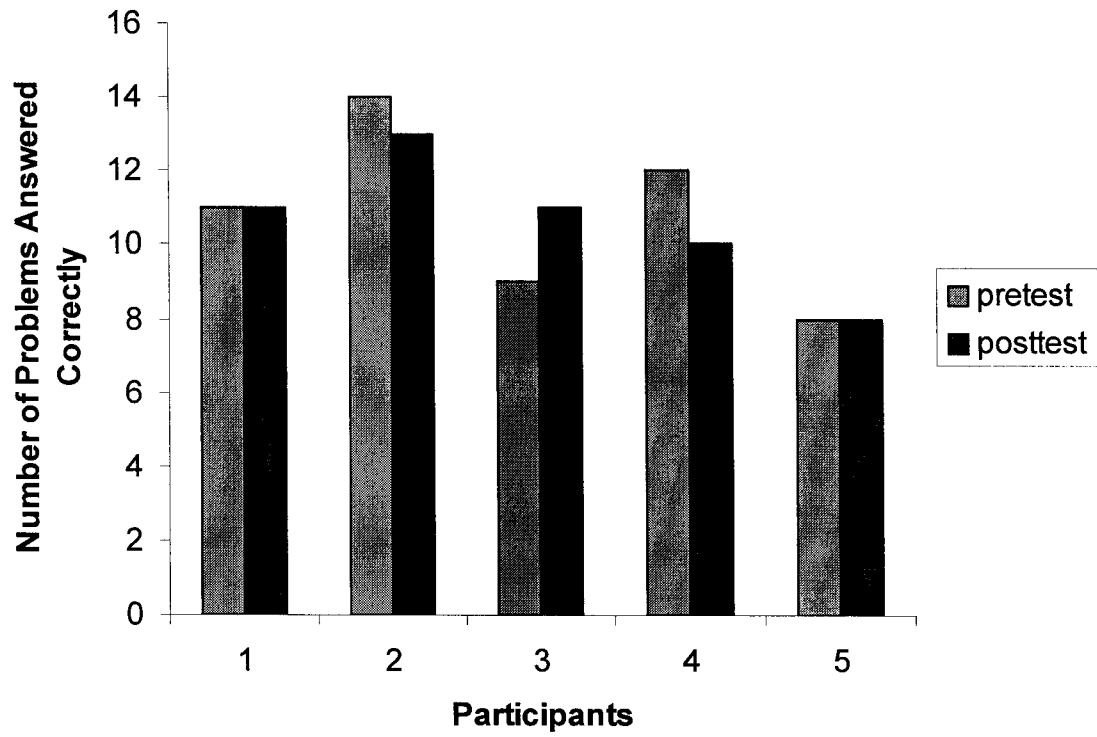


Figure 3. Number of problems answered correctly on Pretest and Posttest for Self-Monitoring with Corrective Feedback group.

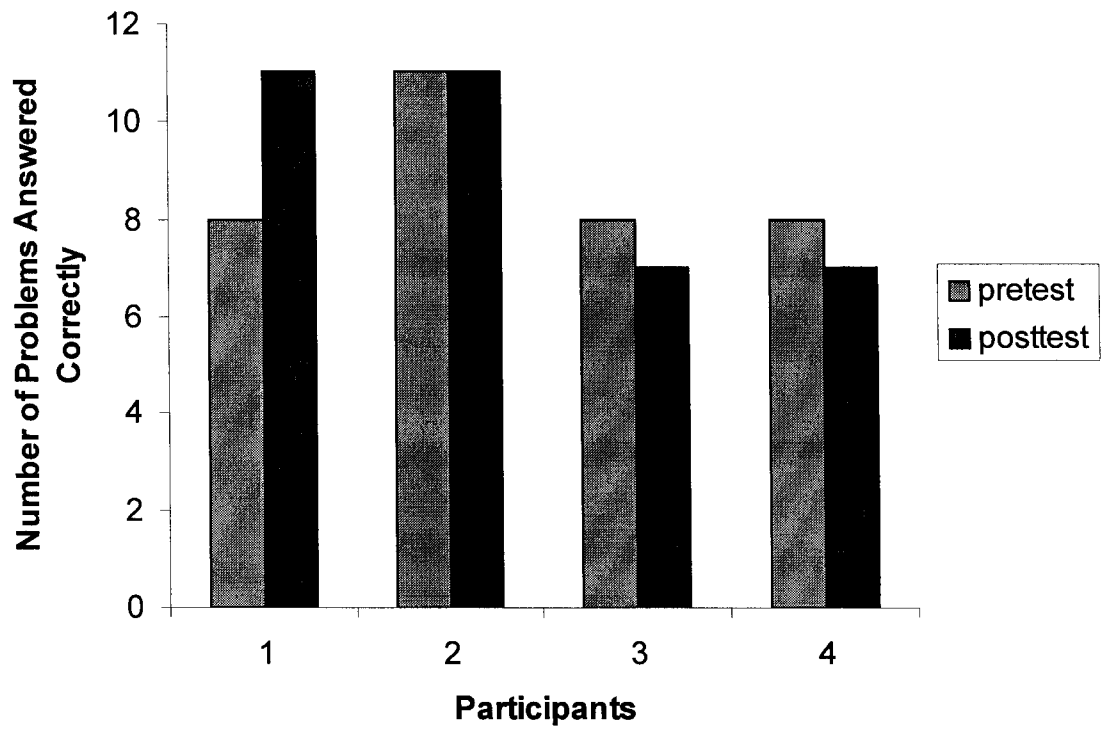


Figure 4. Number of problems answered correctly on Pretest and Posttest for Self-Monitoring with Control group.

