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EFFECTS OF ACTIVE OR PASSIVE ERROR CORRECTION PROCEDURES ON THE LEARNING, GENERALIZATION AND MAINTENANCE OF MATH FACTS BY STUDENTS WITH MULTIPLE HANDICAPS

by
Barbara J. Trzaska

A Thesis

Submitted in partial fulfillment of the requirements of the
Master of Arts Degree in the Graduate Division
of Rowan College of New Jersey
1996

Approved by

Professor

Date Approved 5/13/96

ABSTRACT

Barbara J. Trzaska

The Effects of Active or Passive Error Correction Procedures on the Learning, Generalization, and Maintenance of Math Facts by Students with Multiple Handicaps

1996

Dr. Jay Kuder
Research and Seminar in Special Education

This study examined the effects of active or passive error correction procedures on the learning, generalization and maintenance of math facts by students with multiple handicaps. The hypothesis stated that students actively involved will exhibit greater success in learning their facts. Using an alternative treatment design, six students from Midway School, Lumberton, New Jersey, were introduced, taught and tested on ten flashcards each week for four weeks. Students received the correct answer from an instructor when an error was made. They in turn, either repeated the problem and answer or listened attentively to the instructor's corrected answer. Active Student Responses (ASR) was compared to No Response (NR) Error Correction by looking at each instructional period, Same-Day Test, Next-Day Test, Generalization Test and Maintenance Test for the six students. Results showed that students performed very closely between ASR and NR responses on a short-term basis but the results of learning and retaining facts over time show ASR responses to be stronger. It was also noted that individual differences in ability level and motivation among students may have also played a role in assessing the student's ability to learn the math facts. Future research should look closer at individual ability levels as well as a longer range of time to exhibit the retention of math facts.

MINI-ABSTRACT

Barbara J. Trzaska

The Effects of Active or Passive Error Correction Procedures on the Learning, Generalization, and Maintenance of Math Facts by Students with Multiple Handicaps

1996

Dr. Jay Kuder

Research and Seminar in Special Education

Two variables, Active Student Response (ASR) and No Response (NR), were examined to determine in what condition a student learns, generalizes and maintains math facts most efficiently. Depending on the individual's ability level, this study indicates that initially, learning takes place in both conditions but over time an active student retains and exhibits more facts than a passive listener.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

Throughout a child's education, there are certain facts or skills that would require memorization. The need to memorize is two-fold. One reason would be to produce automaticity in reproducing most frequently used words or facts which contributes to fluency in that fact. The other reason is to allow students to focus on comprehension while freeing themselves from active word or fact recognition, freeing themselves of mundane activities to allow themselves to proceed to higher thought processes. They could be memorizing math facts in addition, subtraction, multiplication or division which are the precursors to being able to accurately and efficiently perform each of these processes. Or it could be sight word vocabulary which would be necessary to know along with the ability to sound out words from their phonetic pronounciation. Or it could be science or social studies vocabulary or facts that require the attainment of facts for the scaffolding process that are not automatically a part of a person's knowledge-base.

In my teaching experiences, I have worked with flashcard procedures that strengthen the skills of students. I have not focused on which characteristics of error correction given to each student would produce effective results in the students acquisition of the given facts. If students were given specific feedback during a flashcard procedure, either to elicit a response from them or to just have them listen to a teacher's response, would their performance be more successful with one of those forms of error correction?

Research in this area has been done using sight words (Barbetta, Heward, Bradley, & Miller, 1994),(Barbetta, Heron & Heward, 1993); science vocabulary (Drevno, Kimball, Possi, Heward, Gardner & Barbetta, 1994); and geography facts (Barbetta & Heward, 1993). These studies found that students performed better when they repeated the teacher's model of the correct response following their error (ASR error correction or active student response) rather than just listening to the teacher's modeling without responding after each error (no-response, or NR error correction). I am interested in extending these studies to the area of mathematics.

STATEMENT OF THE PROBLEM

When school age children who are neurologically impaired or multiply handicapped are asked to memorize math facts, which type of error correction procedure, Active Student Response Error Correction or No-Response Error Correction, will be more effective?

HYPOTHESIS

It is my belief that students learn most effectively by being an active participant and responsible for their own learning. Therefore, by giving them the opportunity to respond with the correct response, immediately following their incorrect response, will reinforce their positive growth with that individual skill.

DEFINITION OF TERMS

Active Student Response Error Correction- When a student incorrectly answers a math fact, the teacher will model the fact with it's appropriate answer and the student will repeat the problem and the corrected answer.

No-Response Error Correction- When a student incorrectly answers a math fact, the teacher will model the fact with it's appropriate answer while the student views the flashcard.

Neurologically impaired- According to the New Jersey Administrative Code means "a specific impairment or dysfunction of the nervous system or traumatic brain injury which adversely affects the education of a pupil. An evaluation by a physician trained in neurodevelopmental assessment is required."

Multiply handicapped- According to the New Jersey Administrative Code means " the presence of two or more educationally disabling conditions which interact in such a manner that programs designed for the separate disabling conditions will not meet the pupil's educational needs. All evident educational disabilities shall be documented. Eligibility for speech-language services as defined in this section shall not be one of the disabling conditions which forms the basis for the classification of a pupil as 'multiply handicapped'. Evaluation by all specialists required in this subsection for the separate disabling conditions being considered for the determination of 'multiply handicapped' are required."

PURPOSE

Memorization of facts is a necessity towards acquiring, maintaining and generalizing information needed towards further educational growth. How to educate our youth in a way that best utilizes time and energy should be a prerequisite for teachers in their classroom instruction. The feedback of teachers to the student's response and the students active participation in their learning process could be an important factor in a student's overall acquisition of necessary skills. If the results are similar as far as the attainment of skills with multiple subjects, would it not behoove all teachers to become aware of this procedure and begin utilizing it?

CHAPTER TWO

REVIEW OF THE LITERATURE

Effective instruction is being challenged in our school systems today. Are our educators providing enough stimulation and motivation for our children to learn? New Jersey Governor Whitman in her second State of the State Address said, "Every piece of evidence... convinces me that the future prosperity of our state depends on the richness of the education we provide to our students. The quality of life in this state tomorrow will be directly determined by the quality of education we provide to our children today." (Martello, p. A6) If this is to be justified, efficient and effective education needs to be brought to the forefront so that educators will use in their classrooms what has been proven to be successful in research.

Success for the students is the key to learning (Slavin & Madden, 1989). All students, regardless of their ability level, should know that their experiences in school will nurture a love for learning. Many students become "burned out" from the amount of frustrations and failures they face in school. Clifford (1990) states that constraint gives a person the desire to escape, freedom gives a person the desire to explore, expand and create.

Teachers should set goals and expectations for their students to strive for. An effective teacher assumes the responsibility for a student's learning outcome by communicating what is expected and why. Allowing the student to be an active participant in a proactive environment, enhances their performance rate in the classroom. (Christenson et. at, 1989; Porter & Brophy, 1988).

Time spent on instruction should be monitored by the teacher because it is a valuable commodity within the class day. Too much class time is spent with the student only listening and attending to what teachers are saying or doing. Students should be actively engaged in responding to their learning. According to Greenwood, Delquadri & Hall (1984), active academic responding time is a stronger correlate of achievement than engaged time. Engaged time includes attending, which is considered a passive response with less impact on student achievement.

Effective programs have comprehensive published instructional material. Remedial and prevention programs have intensive one to one tutoring or computer assisted instruction. Student's progress is assessed frequently and instruction is adapted to individual needs.(Slavin & Madden,1989)

Students should be provided with strategies for monitoring and improving their own learning efforts. Knowing about the subject matter, as well as the misconceptions of ideas that interfere with their learning, are as important as the learning itself(Porter & Brophy,1988). Effective teaching and feedback increases the student's opportunity to respond by providing cues and prompts that lead the student to the correct answer and by carefully sequencing the instruction to maintain high rates of student accuracy (Christenson et.at.,1989). Feedback should be specific regarding the exactness of the student's response as well as contain task-specific praise or encouragement.

There are a multitude of different types of teacher modeling and feedback methods that have demonstrated what could work if used in the classroom. A study by Perkins(1988) on oral reading errors of children with learning disabilities worked with forty-eight boys in grades one through four. They read consonant-vowel-consonant nonsense words that were randomly assigned to one of four treatment conditions: general feedback, corrective/ modeling, corrective/ sound-it-out, and no feedback.

The results of Perkin's study show that "any type of feedback is superior to no feedback and the corrective feedback techniques of modeling and sound-it-out produce the highest correct response rates" (p. 247). Although modeling showed the most improvement immediately, Perkin's study indicates that measuring progress across time shows the most decline in maintaining the sight words. So feedback is necessary, but how does one narrow in on what specifically will work?

Barbetta, Heward, Bradley & Miller (1994) studied learning and maintaining sight words effects using immediate or delayed error correction on the performance of students with developmental disabilities. In their study, four students, aged 7 to 9 from a self-contained classroom used a flashcard procedure under these two conditions. The timing of whole-word error correction with an active student response either immediately following each error on a trial-by-trial basis as opposed to delayed until the end of the session on a massed practice basis was researched.

The results of this study showed that students' performance improved more with immediate error correction than with delayed error correction through the learning process (44% more correct responses), same-day tests (89%), next-day tests (88%), and maintenance tests (M=85%). Taking this another step, if feedback given immediately shows more promise, does the way it is given, i.e., flashcard, videotape or in the natural environment influence the amount a student learns?

Cuvo & Klatt (1992) did an interesting experiment that used informational, warning or safety signs from the community that should be familiar within the environment as the sight words for six mildly or moderately mentally retarded junior high students to learn.

Thirty signs were divided in thirds so that the students would be exposed to the sign either by flashcard, videotape of the sign or within the community in it's natural environment.

Students were given the prompt, "What does the sign say?" and "What would you do if you saw that sign?" for all conditions. The results were positive with all three conditions. The students were able to learn the given signs within the criteria set-up, maintain the signs over time, and generalize them into a new domain of community sight words. The study showed that with using constant prompt delay procedures to transfer stimulus control, mildly and moderately mentally retarded students can learn information easily and rapidly through flashcards or videotape. Learning can occur through different medium as long as the student remains active in it's process. Prompting a response is motivating the student to respond quicker and with ease. What would the difference be between prompting and modeling by the teacher? A study by Espin & Deno (1989) described their research with primary grade children with learning disabilities who worked with two different feedbacks- teacher modeling and teacher prompting- while these students were learning sight words. Using a multi-element, alternating treatment, experimental design, students were given three seconds to read flashcards from the unknown dolch list or basal reading text words the best they could. If there was no response or there was an error, by random selection the teacher would model or prompt the error correction. When the teacher would model/prompt the correct word, the student was given three seconds to respond again, if the answer was incorrect, then the teacher would model/prompt the word a second time with the student being given three more seconds to respond. If there was no response the teacher would move onto the next card. Short term follow-up was one month after the final sessions and long term follow-up was after three months.

The results indicated that modeled words were read more than prompted words during training and after the follow-up. A greater percentage of words were remembered with the modeling feedback strategy.

To continue with a similar feedback strategy that has concentrated with modeling and prompting is a study by Barbetta, Heward & Bradley (1993). Five students, aged 8 to 9, in a self-contained developmental disabilities class, were to learn sight words from a teacher modeling with a whole word correction or by a phonetic prompt error correction. A set of fourteen unknown words were initially introduced or a next day test was given, followed by an instructional period using whole word or phonetic -prompt error correction, followed by a same day test. After 1 or 2 weeks a maintenance test was given on previously learned word sets. The results show that whole word error correction had a stronger outcome in obtaining higher scores with same-day and next-day tests as well as each students individual performance during their instruction than did phonetic-prompt error correction. The bottom line in all this information is that the student is the active participant in the learning that is going on.

Active participation has been explored by researchers. Patton and Hales (1986) believes that "active participation forces the teacher and student in the learning process to spend proportionally more time and activity doing something that requires thinking, responding and verifying what the learner does and does not know." (p.214) In their study, they took a topic not dealt with in four fifth grade classes, probability. They assigned two classes to receive active student participation during the instructional period. The students were told to solve the problem on their own and then show their answer which the teacher visually corrected for correct responses, as opposed to the other two classes that had no student participation. The teacher worked the problem on the board, explaining the procedure. All classes were given posttests to verify what was learned. It was proven that a student's learning is effected with active participation on a posttest with higher mean scores.

An unknown topic irrelevant to further success in the classroom was researched, but what about material necessary for a students growth and development within the school year? Barbetta, Heron & Heward (1993) investigated the effects of student's actively responding during error correction on acquiring, maintaining and generalizing sight words by students with developmental disabilities.

In this study, six students, aged 8 to 9, from a primary self-contained class for students with developmental disabilities were individually assigned twenty unknown sight words to learn. Using an alternative treatment design, each 12 to 15 minute session consisted of an initial introduction to the words/next-day test, an instructional period going three rounds of randomly addressed ASR or NR error correction and verbal praise with each sight word, and a same-day test. After one and two weeks, a test reading sentences with the newly learned sight words from the previous week was administered.

There were seven dependent variables accounted for: number of correct responses during instruction; during same-day tests, the number of correctly read words; during next-day tests, the number of words read correctly; percentage of words read correctly on their next presentation (NTCs); from a two week maintenance tests, the number and percentage of words read correctly from previously learned words; number of words read correctly in sentences on two of the eight word sets for five out of six of the students.

The results keep pointing to ASR error correction as the best outcome. The number of responses in ASR error correction was always 30 because a correct response was the initial correct practice trial responses plus the responses made during error correction. Whereas the mean NR response for the six students was 12.6. Both same-day(80%) and next-day(77%) tests shows higher percentages for correctly answered sight words for all the students. During the instruction, all 6 students made more initially corrected responses during ASR error correction than NR error correction. On just-

corrected words, five of the students read more words following ASR than NR error correction, the sixth student scored identically on both ASR and NR error correction yet made more mistakes with NR error correction. Five of the students maintained more ASR error correction words on tests given two weeks later. One student performed the same on both error corrections but learned 19 more words with ASR error correction. When asked to read previously learned words in a sentence, only two students had a higher percentage with ASR error correction than NR error correction, three other students did the same or a little higher with ASR error correction.

The interest continues if a student is responding actively on sight words and shows improvement, what about geography facts which is more complex to learn? In 1993, Barbetta & Heward reported an experiment which investigated the effects of active student response during error correction versus no response of the student during error correction on the appropriation and preservation of geography facts of students with learning disabilities.

In this study, three students, aged 10 and 11, from a self-contained class who were mainstreamed for geography, attempted to learn unknown capitals of states and countries on six dependent variables (number of ASR; percentage of correctly stated capitals during practice trials; correctly stated capitals on the next-trial corrects or NTCs; same-day tests correctly stated capitals; next-day tests correctly stated capitals; correctly stated learned capitals on maintenance tests).

Using an alternate treatment design, seven ASR capitals and seven NR capitals were randomly selected and taught during the instructional period. Each session consisted of an initial introduction of the capitals or next day test followed by an instructional period of three rounds of the fourteen capitals followed by a same day test which was then followed by a maintenance test if necessary.

If a student responded correctly to a geography card, a short verbal praise was spoken by the researcher with "Good!" or "Right!". During instruction if a student made a mistake on an ASR capital, the researcher showed the answer and said, "No, its _____. What capital?" The correct answer was followed by "Good" or "Yes" and the next card was presented. When a student was answering to an NR capital, the correct capital was shown while the researcher said, "No, its _____. Look at it." Praise was given for paying attention occasionally with, "Good looking" and the next card was shown.

The results of the study demonstrated that more active student responses were made from ASR error correction because the student would respond with 21 correct responses each session yet not always respond favorably with the no response error correction (mean 7.3). ASR error correction capitals scored higher than NR error correction in both the same-day (66%) and next-day tests (77%). There were fifteen more geography facts learned with ASR error correction than with NR error correction.

In 1994, Drevno, Kimball, Possi, Heward, Gardner & Barbetta conducted another study which replicated two other studies they had previously conducted. In this study, they examined the effects of active student response during error correction on the ability to initially learn the facts, the ability to retain the facts over time, and generalization of science vocabulary by elementary students.

In the study, five students were assigned twelve unknown science terms to learn. During the instructional period, the student was asked to answer the definition of the science term using an alternative treatment design, with each word randomly assigned ASR or NR error correction on seven dependent variables (percentage of NTCs- next-trial corrects; number of same-day test definitions said correctly; percentage of maintenance tests learned definitions said correctly after one week; percentage of maintenance and generality tests written correctly after one week; percentage of end-of- the- study learned definitions said correctly).

When a student answered incorrectly, the researcher would either tell the answer and have the student repeat the answer (ASR) or the researcher would tell the answer and have the student attend, only listening, to the answer (NR). During each session, there would be an initial introduction or next day test, an instructional period where the researcher would give feedback for an incorrect answer, and a same day test and/or post-test.

The results indicate that students learned more science facts through the ASR error correction technique as opposed to the NR error correction technique. Even the practice trials and NTCs indicate 50% more correct responses during instruction. These results indicate that ASR error correction has better outcomes than NR error correction with more complex academic tasks like science terms and that the effects are similar with both regular and special education children.

My study is a replica of three previous studies regarding the effects of active student responses with error correction procedures.(Barbetta & Heward, 1993; Barbetta & Heward, 1993;Drevno, Kimball, Possi, Heward, Gardner & Barbetta,1994). The studies were across different curricular areas- geography facts, sight word vocabulary and science vocabulary, but were still covering whether a student would learn more effectively with active participation after an error was made or with a passive, listening only response to a teacher's correction after an error was made. One of the three studies examined students in elementary classes in general while the other two looked at the effects with students with developmental or learning disabilities.

All findings indicate that students who are actively involved in their academic learning, classified or not, are able to perform better during their instruction, learning from their instruction, and maintaining and generalizing these skills over time.

In my study, I will be examining the acquisition of math facts in addition, subtraction or multiplication, using Active Student Response versus No Response Error Correction during Instruction, Same-Day Testing, Next-Day Testing, a written test of facts acquired over each week, and a written post-test after one week. I hope to reproduce and extend the previous findings into the mathematics curricular area.

CHAPTER THREE

DESIGN OF THE STUDY

POPULATION FOR THIS STUDY

The population for this study consisted of six students, ages 8 through 12, from grades one through six attending the Midway School located in Lumberton, New Jersey. Midway School, which has been in existence for about twenty years, is a non-profit organization serving a population of children who are multiply handicapped or neurologically impaired. It is a small, family-oriented type of school, giving students the opportunity to grow and mature in an environment that is nurturing and caring towards their disability. The sending districts are Mt. Holly, Bordentown, Willingboro, Pemberton, Browns Mills, Fort Dix, and even districts from the shore. Midway School gives the student a chance to go back to the public school special program when they're ready to or after time has passed, when possibly another placement would be more appropriate.

METHOD OF SAMPLE SELECTION

Initial interviews with the principal and individual teachers for these students determined which students would possibly meet the criteria for inclusion into this study. A letter for parental consent was sent home with each student. Although I will be the one conducting the research, I do not have any background information to know if each student meets my individual criteria. The final decisions were made by the student's classroom teacher based on the return of the consent form and the student meeting the following criteria:

1. A child with special needs
2. Counts on his/her fingers or who doesn't know their multiplication facts
3. Good attendance
4. Good health
5. Parent stability
6. No major behavior problems
7. Parent consent form returned and signed

The students who participated in this study are considered to be neurologically impaired or multiply handicapped. All of the students who participated in this study have experienced some degree of difficulty in learning their math facts. It was determined by their teachers and parents that one to one instruction with their math facts would be beneficial to them.

DESIGN OF THE RESEARCH

An alternating treatment experimental design was used to determine the differing effects of Active Student Response (ASR) and No Response (NR) Error Correction while instructing students with math facts. Both types of error corrections occur after an incorrect response was given by the student. With Active Student Response Error Correction, the instructor repeated the problem with the corrected answer and the student repeats the entire problem with the corrected answer. No Response Error Correction is similar to Active Student Response but the student only listens to the instructor's corrected response, they do not respond verbally with the corrected problem and answer.

PRETESTING

Each student was asked to give an answer to math facts, either addition, subtraction or multiplication based on the individual's ability. The correctly stated facts were separated from the incorrectly stated facts. Each incorrect fact was presented two times as a check that the fact was unknown. These facts were used as the facts to be learned during the research.

Each week five math facts with ASR error correction and five math facts with NR error correction were taught. The random order of the cards with the two error corrective feedback conditions was done by quickly shuffling the entire set of ten math fact cards (5 ASR and 5 NR) following each instructional round and each testing session.

DEPENDENT MEASURES

Number of Active Student Responses

During the instructional period, the number of correct responses on ASR and NR error correction was counted. Initially correct responses plus responses made during error-correction trials were included on the ASR error correction response. Only the initially correct responses were recorded on the NR error-correction response, except when the student unconsciously responded verbally after the teacher model.

Percentage of Corrected Facts Stated Correctly on their Next Presentation (referred to as next-trial correct, NTC)

The measurement of math facts that were stated correctly following an error and error correction technique, were noted by calculating the percentage of facts known. All responses from the next-day trials, instructional period and same-day trials were included in the analysis of NTCs.

Math Facts Stated Correctly on Same-Day Tests

Each day following the instructional period, the student was shown their math facts for them to recite the answers within the three to five second time period. There was no response from the researcher, yet the student was shown the correct answer at the bottom of the math fact problem. Their responses were recorded.

Math Facts Stated Correctly on Next-Day Tests

On the second through fifth day, each student was initially shown the math facts from the previous day to "see what they remembered from yesterday." Their responses were recorded with no feedback from the researcher, other than showing the flashcard with the correct answer.

Number of Math Facts Written Correctly Following the Last Session of the Week on a Written Generalization Test.

All facts were written three times on the generalization test that followed the last day of instruction. The number of correctly written facts were recorded.

Number of Previously Learned Math Facts Written Correctly on a One-Week Maintenance Test.

The maintenance test that was administered the previous week was regiven. The number of these previously learned math facts written correctly on the one-week maintenance test was recorded.

PROCEDURE

Ten unknown facts were selected each week for four weeks. They were written on 3 by 5 index cards and ASR or NR error correction was randomly selected for each fact. Each student was seen for 10 to 15 minutes each day.

On the first day of each week, the student was introduced to their new facts. On the other four days of that week, the students were asked to show the researcher what facts they remembered from the previous day. No responses or praise was given by the researcher but the students were shown the correct answer with each reply. Their responses were recorded as the next day test.

An instructional period followed, where the student would state the problem and the answer to the math fact within three to five seconds. Some of the students could not perform under pressure so the three second time limit was extended for them. If a correct response was given by the student, the researcher would give positive praise and go onto the next flash card. If an incorrect response was given by the student, the researcher would respond in one of these two ways:

For an Active Student Response (ASR) Error Correction: The researcher said, "No, this fact is _____. Say it." Then the researcher gave the student verbal praise like "Yes, that's the correct answer."

For a No Student Response (NR) Error Correction: The researcher said, "No, this fact is _____. Look at it." Then the researcher gave verbal praise for attending like "Good looking."

Each series of ten facts was repeated three times and the student's response was recorded. The pile of flashcards were shuffled in-between to vary the order of the cards.

Following the instructional period each student was given a same day test. This was done by flipping through the ten flashcards while the student announced it's answer. The correct answer was shown but no response from the researcher was given. Their responses were recorded and the session ended.

On the last day of the session, the students were given a written generalization test and a one-week maintenance test. All the facts from that week and the previous week were repeated three times on a page to verify the acquisition of the facts. The correct answers were recorded according to their ASR or NR error correction technique during the instructional period.

CHAPTER FOUR

DATA ANALYSIS

The purpose of this study was to evaluate the effectiveness of a student's active involvement (ASR or active student response error correction) versus a listening attentiveness (NR or no response error correction) to an instructor's verbal corrective feedback. My hypothesis was that students learn most effectively by being an active participant and responsible for their own learning. I felt that if students were given the opportunity to respond with the correct response immediately following their incorrect response, it would reinforce their positive growth with that individual skill.

During this study, all students were pretested with the appropriate math flash cards in addition, subtraction or multiplication. A "Fast Facts Matrix", developed by Ted S. Hasselbring and Laura I. Goin (1989) was utilized to plot known and unknown facts. Addition facts were the first group of facts to be pretested and taught. When all addition facts had mastery or exposure, a subtraction pretest was administered and a new matrix developed. Finally, multiplication facts were introduced when all addition and subtraction facts were either known or used in the research from the previous weeks.

Student 1 had three weeks of addition and one week of subtraction. Student 2 was absent the final week of my research and had three weeks of addition introduced. Student 3 had two weeks of subtraction and two weeks of multiplication. Student 4 had four weeks of addition. Student 5 had two weeks of addition, one week of subtraction and one week of multiplication. Student 6 had four weeks of addition.

The data for this study was obtained by analyzing the dependent variables stated earlier in Chapter Three.

Number of Active Student Responses:

When comparing ASR error correction with NR error correction there were more active student responses during the instruction period. This was due to the fact that active student responses per session was a constant 15 responses for each student (those facts originally stated correctly by the student as well as those verbally corrected by the student following the instructor's corrective feedback), whereas the mean number of active student responses per session for each student with NR error correction (those facts originally stated correctly with some inadvertent corrections by the student following the instructor's corrective feedback) was: Student 1 - 10.65; Student 2 - 7.3; Student 3 - 12.65; Student 4 - 8.75; Student 5 - 13.15; Student 6 - 6.3; (group mean of 9.8 active NR student responses per session).

Practice Trials Stated Correctly:

Practice trials or the instructional period are the three sets of ten flashcards reviewed each day where the error correction procedure takes place. Prior to the Practice Trials is the Next-Day Test or the introduction of new facts. Following the Practice Trials is the Same-Day Test and on the fifth day, the written Generalization Test and written Maintenance Test.

When comparing the total number of initially correct responses on math facts between ASR error correction and NR error correction with the number of instructional trials held constant under both conditions, the results, as indicated in Table 1, show that the sum total for all six students was 17 more ASR responses that NR responses.

Number and Percentage of Corrected Facts Stated Correctly on their Next Presentation (Referred to as Next-Trial Correct, NTC):

Table 1 illustrates in the two right-hand columns that four out of the six students correctly answered more just-corrected math facts during their next presentation (NTCs) with ASR error correction than with NR error correction.

Table I. Percentage and Number of Correct Responses during Practice Trials and Corrected Responses Stated Correctly on their Next Presentation

	Practice Trials		Next-Trial Corrects	
	ASR	NR	ASR	NR
Student				
1	72% 217a	71% 213	59% 49/83b	66% 59/90
2	57% 129	49% 110	51% 49/96	33% 38/116
3	80% 240	84% 253	40% 24/60	32% 15/47
4	63% 190	57% 171	48% 53/110	39% 50/128
5	81% 244	88% 265	80% 45/56	86% 30/35
6	43% 130	40% 121	31% 53/169	24% 42/179
Group Mean	66.7%	65.7%	47.6%	39.3%
Group Total	1150	1133	273/574	234/595

a) Numbers represent the total number of correct responses. Total possible is 300 (Student 2= 225) per set.

b) Numerator represents total number of next trial corrects, denominator the total number of errors during practice trials.

Math Facts Stated Correctly on Same-Day Tests:

Each student was given 20 same-day tests immediately following their instruction , except for Student 2 who was given 15 same-day tests because he was absent for the last week.. Figure 1 illustrates their performance on these tests. Same-day test scores on ASR facts were higher than scores on NR facts on 33 (29%) of 115 tests, the same as NR facts on 44 tests (38%), and were lower than scores on facts instructed with NR error correction on 38 (33%) tests.

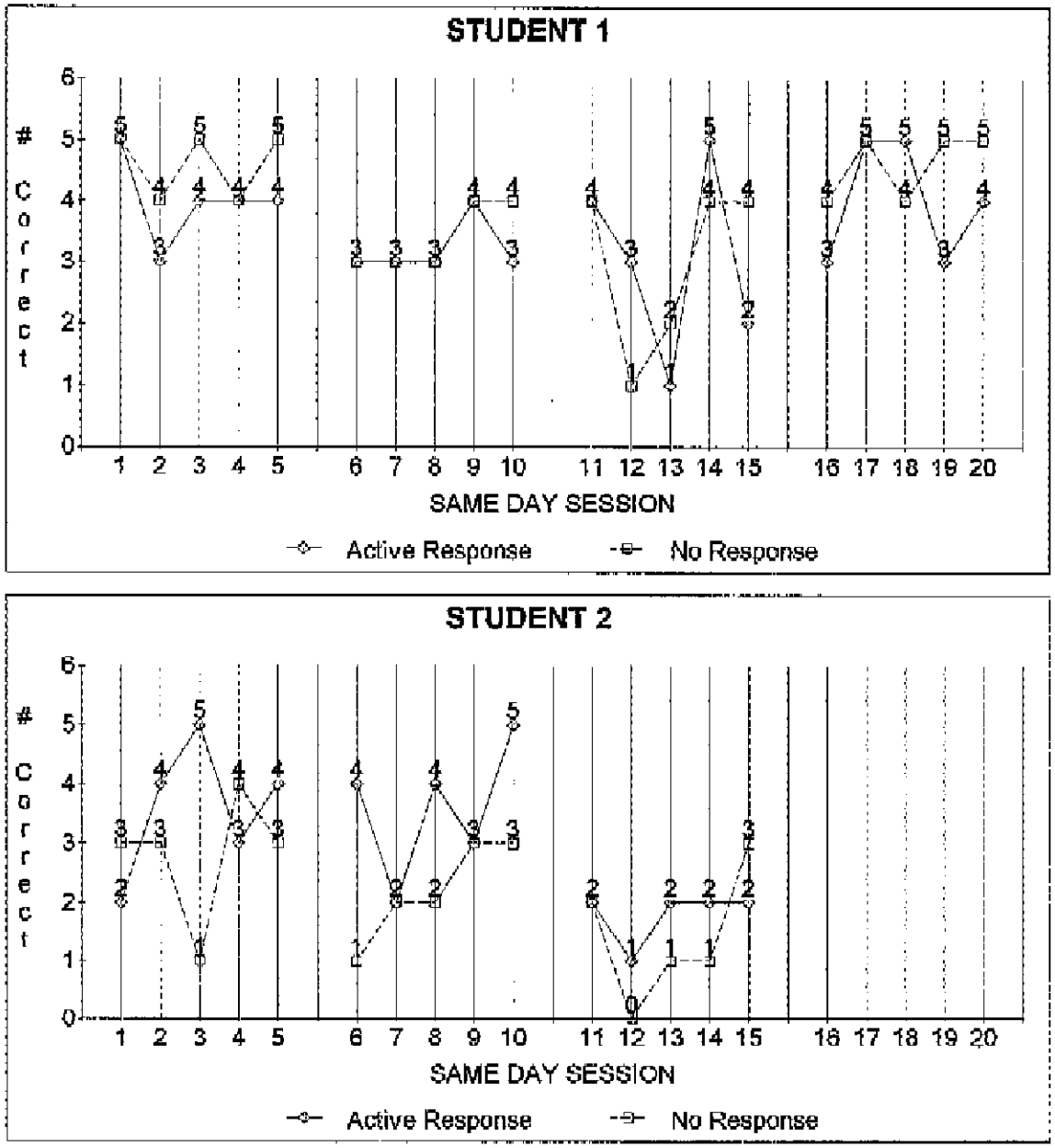
When ASR and NR Error Correction were compared on each successive day of instruction, the group mean same day test scores across all math fact sets were:
Day 1: ASR=16.3, NR= 16.0; Day 2: ASR = 15.3, NR= 16.2; Day 3: ASR= 22.0, NR= 18.3; Day 4: ASR= 20.0, NR= 22.0; Day 5: ASR= 21.2, NR= 23.0 (TOTAL MEAN: ASR=19.0; NR= 19.1).

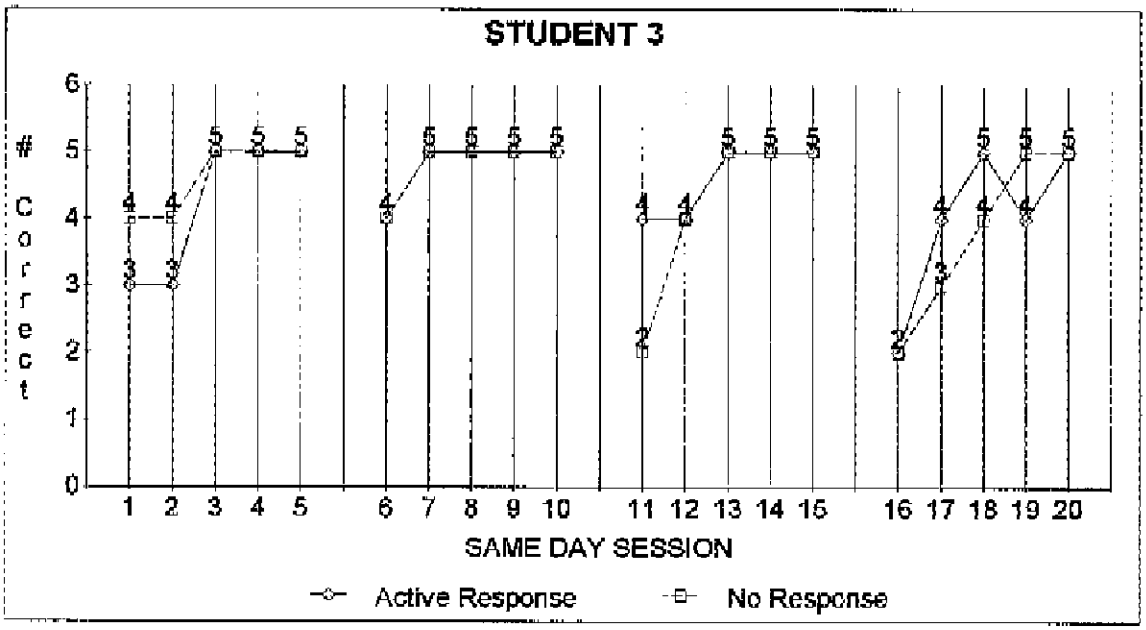
Math Facts Stated Correctly on Next-Day Tests:

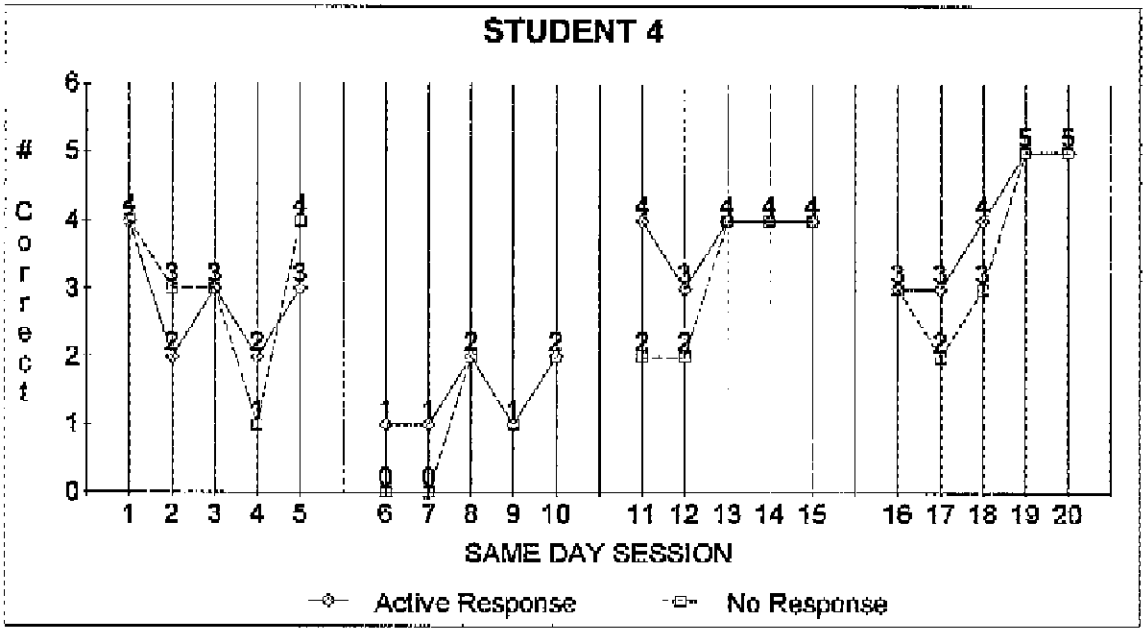
Five of the six students were given 16 next-day tests; student 2 was given 12 tests as illustrated in Figure 2. Next-day test scores on math facts trained with ASR error correction were higher than scores on NR math facts on 26 (28%) of 92 tests, the same as NR math facts on 42 tests (46%), and lower than scores with NR error correction on 24 (26%) tests.

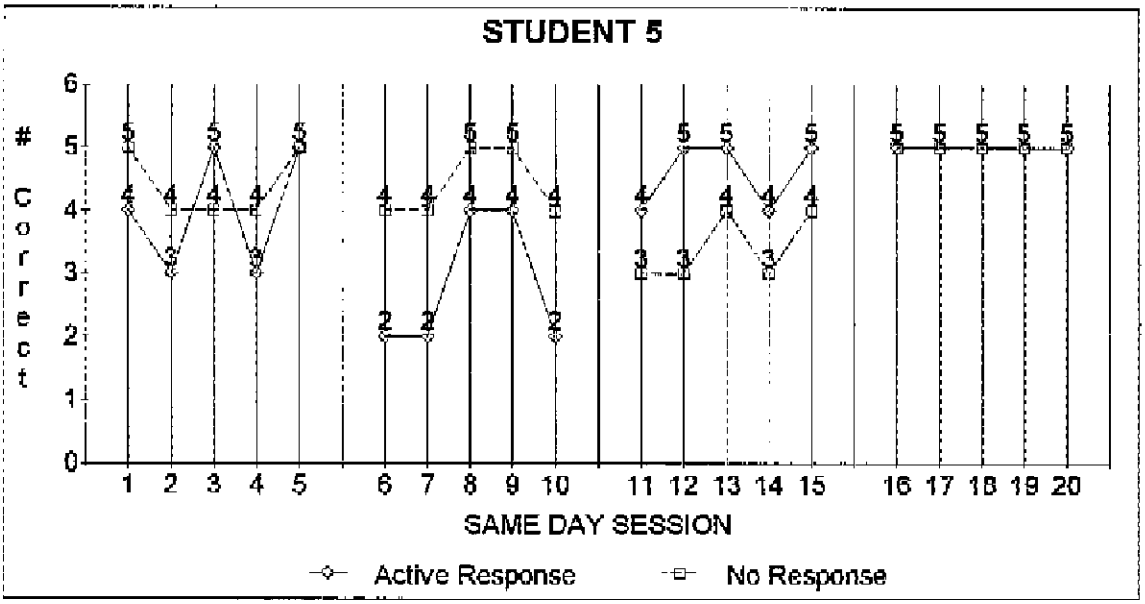
As a group, the mean next-day test scores on each successive day of instruction across all math fact sets were:
Day 1: ASR=14.25, NR= 14.0; Day 2: ASR= 17.25, NR= 17.0; Day 3: ASR= 21.0, NR= 21.0; Day 4: ASR= 21.0, NR= 20.0 (GROUP TOTAL MEAN: ASR= 18.4; NR= 18.0).

Figure 1. Number of math facts spoken correctly on Same-Day Tests given directly after instruction. Diamond data points indicate the number of responses taught with ASR Error Correction; square data points indicate the number of responses taught with NR Error Correction.




STUDENT 3
Correct
SAME DAY SESSION
Active Response
No Response


STUDENT 4
Correct
SAME DAY SESSION
Active Response
No Response


STUDENT 5
Correct
SAME DAY SESSION
Active Response
No Response

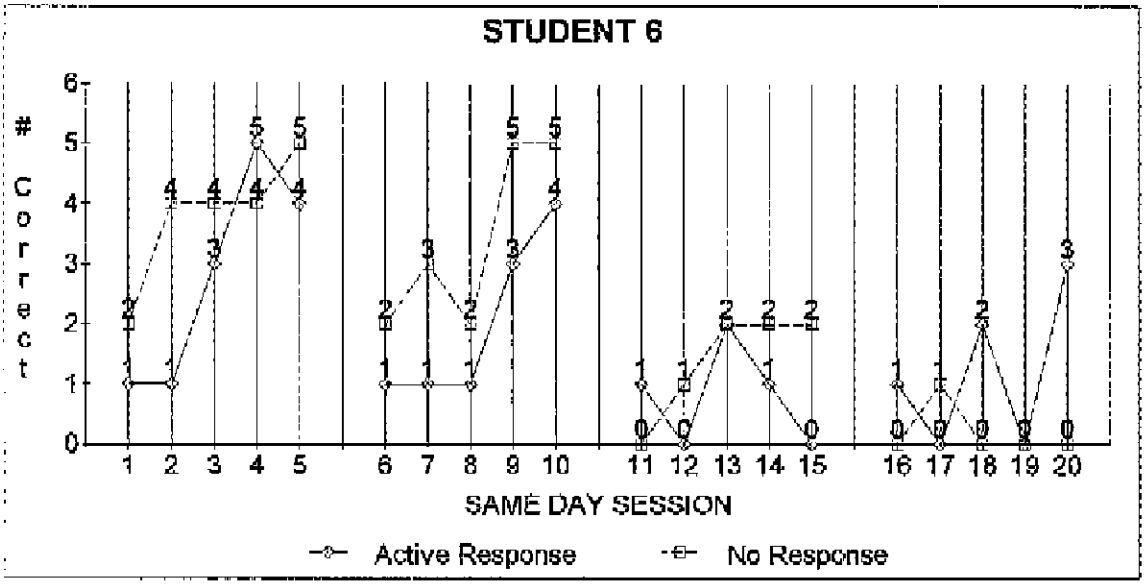
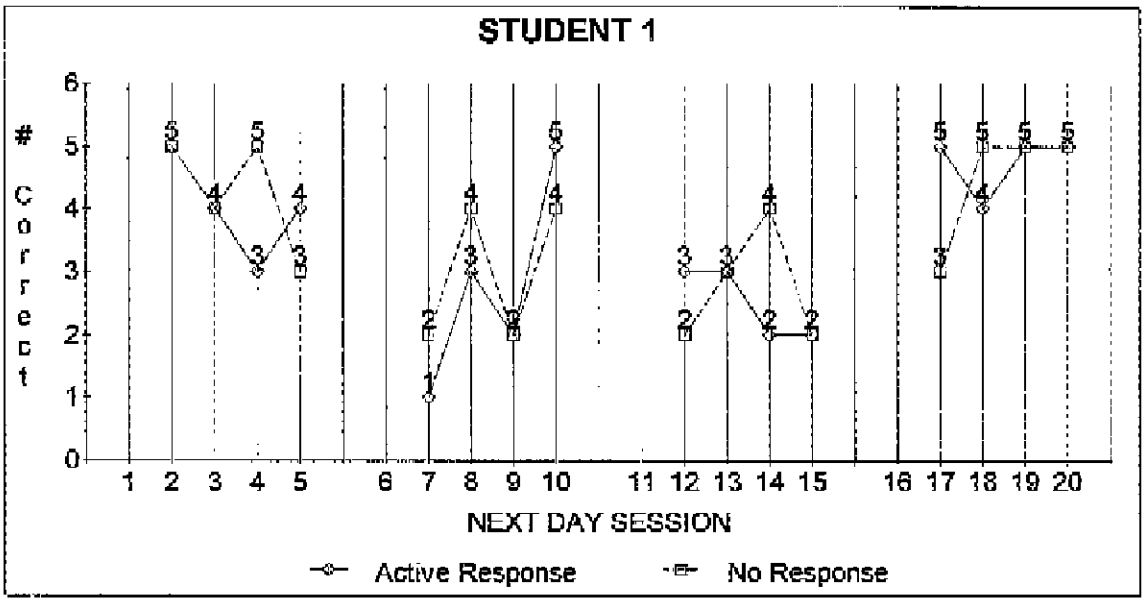
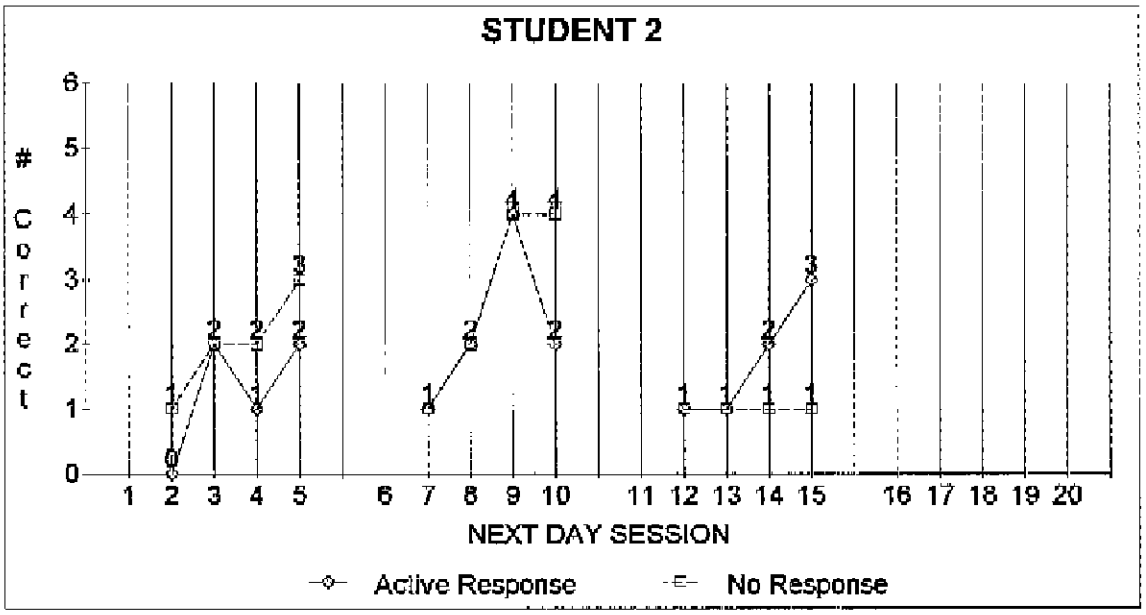
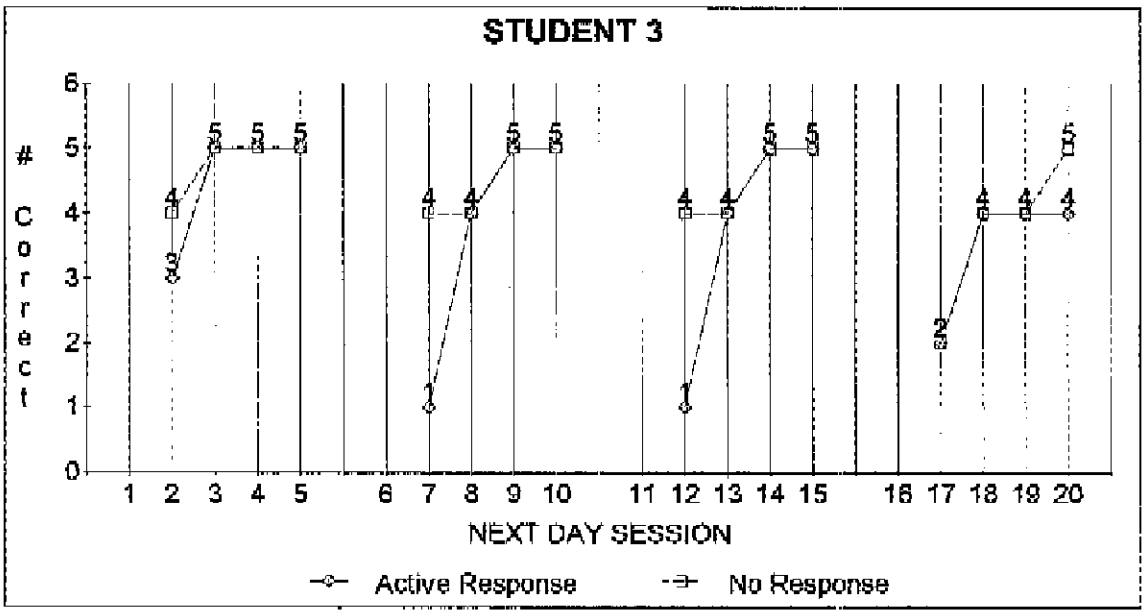
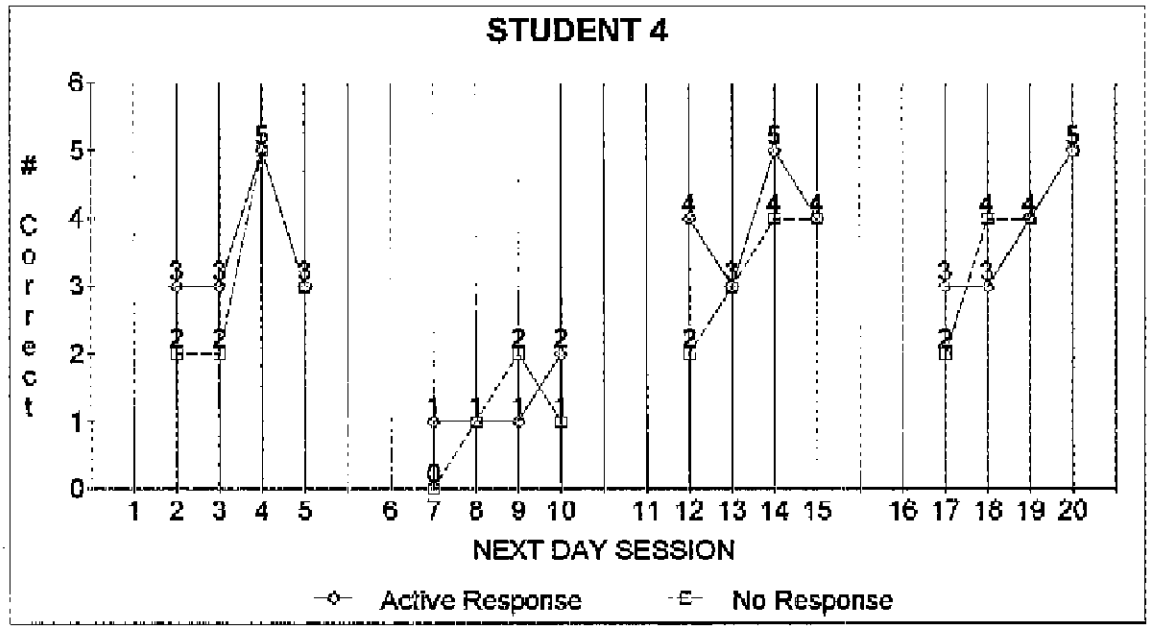

STUDENT 6
Correct
SAME DAY SESSION
Active Response
No Response

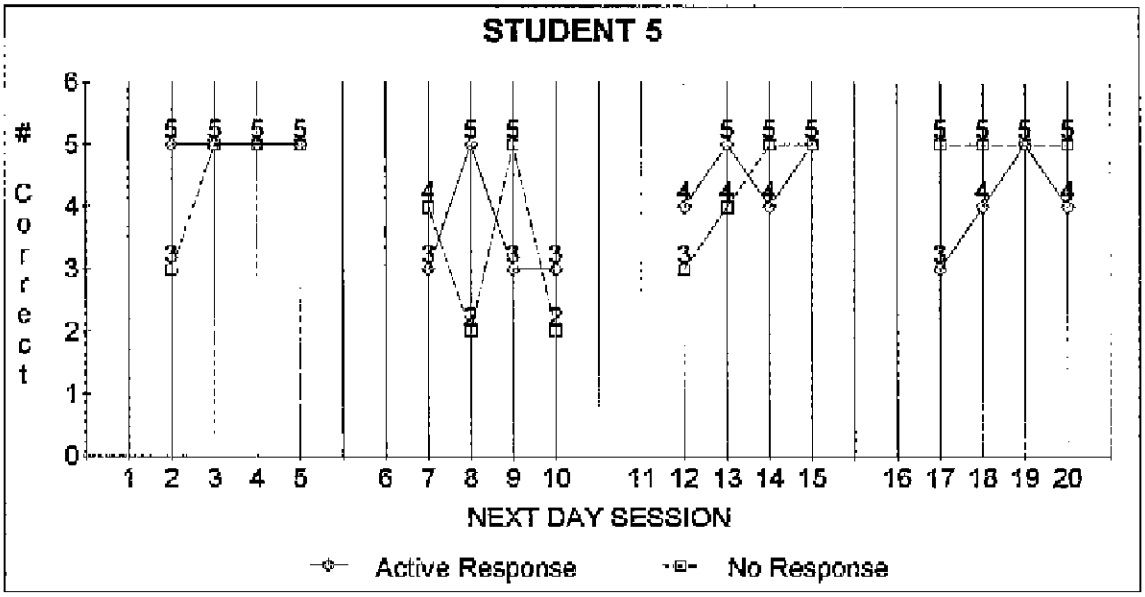
Figure 2. Number of Math Facts spoken correctly on Next-Day tests given the day after instructional period. Diamond data points indicate the number of correct responses on facts taught with ASR error correction; square data points indicate the number of correct facts taught with NR error correction. Separate fact groups are indicated by breaks in data paths.

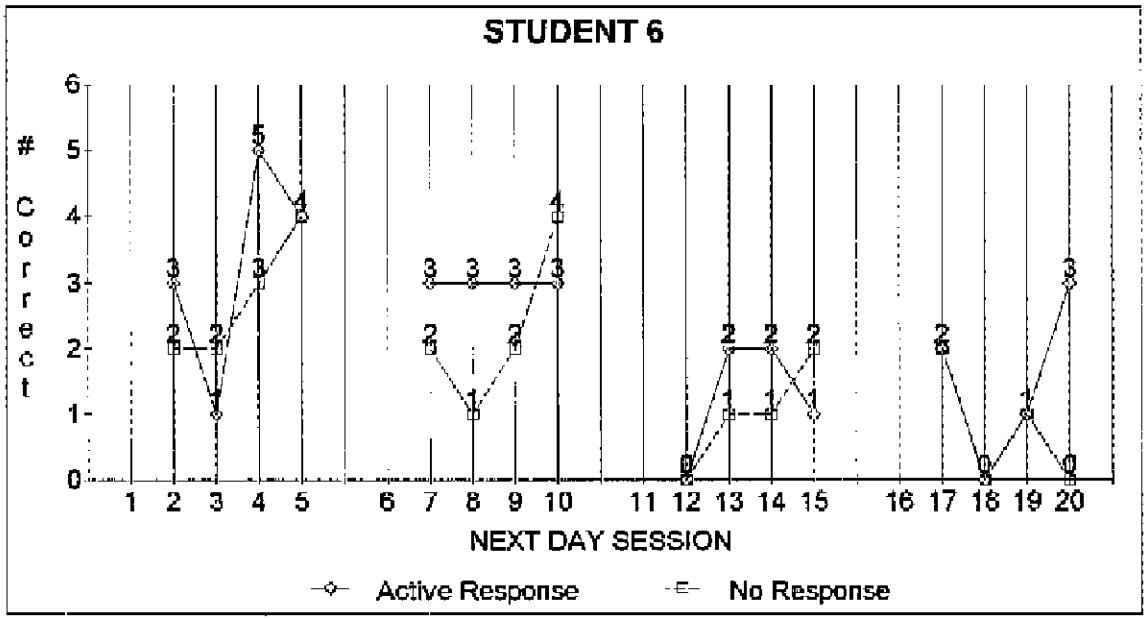





STUDENT 3
Correct
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
NEXT DAY SESSION
Active Response
No Response


STUDENT 4
Correct
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
NEXT DAY SESSION
Active Response
No Response


STUDENT 5
Correct
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
NEXT DAY SESSION
Active Response
No Response


STUDENT 6
Correct
0
1
2
3
4
5
6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
NEXT DAY SESSION
Active Response
No Response

Number of Math Facts Written Correctly Following the Last Session of the Week on a Written Generalization Test:

The number of correct facts during the final two sessions (Day 4 and Day 5) of the Same-Day Tests showed the ASR error correction facts (64) to be lower than the total NR error correction facts (78). Yet, when comparing the total number of correctly written previously learned facts, the group mean shows ASR facts (84.4%0 to be higher than NR facts (80.7%).

Number of Previously Learned Math Facts Written Correctly on a One-Week Maintenance Test:

The total number of previously learned math facts written correctly on a one-week Maintenance Test was higher with ASR error correction facts than with NR error correction facts. (Group Total Mean: ASR= 76.5%, NR= 65.4%)

Table 2. Percentage and Number of Correct Responses during the Final Same-Day Written Generalization Test and on a One-Week Maintenance Test.

	Final Same-Day Written Generalization Test		One-Week Written Maintenance Test	
STUDENT	ASR	NR	ASR	NR
1	100% 11/11a	87% 13/15	82% 9/11b	80% 12/15
2	50% 3/6	83% 5/6	17% 1/6	17% 1/6
3	100% 19/19	100% 20/20	100% 19/19	100% 20/20
4	73% 8/11	90% 9/10	73% 8/11	50% 5/10
5	92% 12/13	69% 11/16	85% 11/13	81% 13/16
6	25% 1/4	46% 5/11	25% 1/4	0% 0/11
Group Mean	84.4%	80.7%	76.5%	65.4%
Group Totals	54/64	63/78	49/64	51/78

a) Numerator equals the total number of correctly written previously learned facts on a Written Generalization Test given following the final day of instruction. The denominator equals the total number of learned facts stated by the correct verbal answers on Days 4 and 5 of the Same-Day Test.

b) Numerator equals the total number of correctly written previously learned math facts on a written maintenance test given one week after instruction. The denominator equals the total number of learned facts stated by the correct verbal answers on Days 4 and 5 of the Same-Day Test.

CHAPTER FIVE

SUMMARY AND CONCLUSION

In my study, I was interested in the effects of students' active involvement during error correction on their learning, generalization and maintenance of math facts. I compared the rate of acquisition of math facts from each of six students with multiple handicaps when exposed to the facts in two separate ways. One way, called ASR response, had the students repeat the corrected answer to a problem they initially answered incorrectly after listening to the instructor say that problem and answer correctly. The second way had the students listen attentively to the teacher's corrected response but not repeat the corrected answer following an initial incorrect answer on their part.

My hypothesis for this study was that students learn most effectively by being an active participant and responsible for their own learning. Therefore, by giving them the opportunity to respond with the correct response immediately following their incorrect response will reinforce their positive growth with that individual skill.

As an extension of previous research as stated in Chapter Two, I was anticipating finding like results with a different subject area. In previous studies, the active participation of students with error correction procedures was stronger than a student solely attending the correct response towards academic learning, ability to perform during instruction, and maintaining and generalizing these skills over time.

My results indicate that on the surface, as the actual instructional period is taking place, the percentage of learned facts, whether being an active or passive student during error correction, does not show any monumental difference. As an educator in a

classroom with my results, it would appear that a student is learning the facts necessary regardless of their participation in the process of learning. However, over time, in a long range perspective, an active participant in error correction shows more recall than a passive learner and it can be generalized from a spoken active role in learning onto a written fact sheet over time.

One of the limitations of my study was that I was not the everyday instructor of these students. Initially they had a "getting used to me" period. To ease the transition and allow the study to flow smoother, I rewarded the students with stickers many times during each session as well as giving them a prize at the end of the week for attending. This worked well in keeping them focused and the research progression yet I felt it was unnatural to keep working with an external reward posted in front of them.

I found two different themes running throughout my study. One had to do with the population of students I had randomly chosen for my study. The other had to do with how the facts were recalled over time and with a different medium.

The six students' ability to learn was so varied that I felt in order to interpret their answers with more precision, it was necessary to know more about the student's ability. Students 3 and 5 appeared to be thirsty for knowledge. They were academically ready and receptive to respond to more growth. It did not matter, as learning was taking place, whether they were active or not participating with their answers. They wanted to learn and had the ability to learn. Student 1 had the desire to learn and the willingness to learn but lacked the confidence to succeed. Paradoxically, this student only wanted to respond with a correct answer, wanting to perform perfectly and be the best of everybody. Student 4 had an emotional background that stood in the way of concentrating on the material at hand. Always looking for approval on the outside made it difficult for this student to internalize the information. Different weeks had different results depending on the mood, ease of recall of the facts or the way the world outside was being perceived by

the student. Students 2 and 6 had little progress over time with the facts yet still did show some growth. These two students came willing to work, trying their hardest to do everything to the best of their ability. Yet their mental capabilities and ability to recall facts from day to day kept them at a low functioning level. To some extent, the results of this study reflect the abilities of the students' tested.

The end result of ASR during practice trials was marginally higher that NR response with students 3 and 5 being self motivated learners regardless of the error correction condition involved. A constructivist point of view given by Hermine Marshall (1992) states that a more appropriate starting point in acquiring knowledge would be the nature of learning itself and the various ways of learning for different purposes. I feel that with my study, each child performed to their own ability level and the comparison of ASR to NR error correction responses depend overall on the ability of the student to perform in general.

The second theme that surfaced was comparing short-term results to long-term results. During the instructional sessions, the Same-Day Tests and written Generalization Tests, the performance of the students was marginally different. On a short-term basis, facts were the same or slightly higher on the NR response than the ASR response. Yet, over time, starting with the Next-Day Tests and continuing with the one-week Maintenance Test, ASR responses indicated a stronger outcome and response than NR responses. On the Same-Day Tests, NR facts were higher that ASR facts but on the Next-Day Tests, ASR facts were higher than NR facts. This indicates that on a short range of learning, NR responses outweigh ASR responses but with a long range outlook, ASR is retained over time. Each day on the Same-Day test the group mean fluctuated with which error correction produced higher results. But on the Next-Day Test the outcomes remained constant. ASR remained higher on all days except Day 3 where both were the same.

Continuing with this idea, I looked to the Generalization Tests versus the Maintenance Tests and found similar results. Students 1, 3 and 5 scored higher or the same on ASR as NR responses. These students were the "achievers" or "self-motivated" learners. Students 2, 4 and 6's scores were lower on the written Generalization Tests. However, on the One-Week Maintenance Test, Students 2 and 3 scored the same on both ASR and NR response and all the other students scored higher on ASR than NR response. This shows that the recall of facts, over time, is stronger when a student is an active participant to their learning. I believe that when students are actively speaking the facts while in the instructional process, they may be internalizing the information at the same time and have a stronger ability to recall those facts in the long run. Future research should examine generalization and maintenance of facts over a longer period of time than just one week later to see how long facts will be retained.

These results confirm my hypothesis as well as the research by previous studies. In the three studies that I attempted to replicate, Barbetta, Heron & Heward (1993), Barbetta & Heward (1993), and Drevno, Kimball, Possi, Heward, Gardner & Barbetta (1994), the positive outcomes appeared in all stages of the research process from beginning to end. These studies showed Active Student Responses to be a stronger indicator of correct responses than passively responding to the error correction procedure. The amount of variation in percentages or numbers from ASR Error Correction to NR Error Correction Procedures was greater in the previous studies than the findings in mine. Table 3 is a visual comparison of results from these three studies and my study.

Table 3. Percentage of terms stated correctly as a function of ASR & NR Error Correction.

SUBJECT OF STUDY	PRACTICE TRIALS		NEXT-TRIAL CORRECT		SAME-DAY TESTS		NEXT-DAY TESTS		MAINT. TESTS	
	ASR	NR	ASR	NR	ASR	NR	ASR	NR	ASR	NR
Sight Words	64%	44%	22%	13%	80%	7%	77%	12%	2 Week 87%	77%
Geography	57%	36%	20%	16%	66%	8%	77%	17%	1 Week 83%	69%
Science Facts	33%	21%	15%	10%	49%	32%	41%	29%	1 Week 78%	77%
Math Facts	66%	64.6%	51.5%	46.5%	29%	33%	28%	26%	1 Week 64%	55%

SUBJECT OF STUDY	GENERAL-IZATION TESTS		END OF STUDY TESTS	
	ASR	NR	ASR	NR
Sight Words	93%	89%	-	-
Geography	-	-	-	-
Science Facts	76%	63%	42%	24%
Math Facts	73%	79%	-	-

Differences may have occurred because of my interpretation of what was done in the other studies. The way I executed the research may/may not be identical to the original research which would effect the accuracy of this replication. Or differences may have occurred because each study, along with changing the subject to be compared, varied with the type of population of students that were tested (students with learning disabilities, developmental disabilities, multiple handicaps, or students in regular education classes), the number of students that were tested (3. 5 or 6), and the amount of terms tested per week (10,12,14,or 20).

I initially did not see the benefits of being an active participant in my study. It could have been because of the nature of learning math facts as opposed to other subjects or because of the backgrounds of the students. My results were not as impressive as those in the other studies. Yet I do see long range positive growth with facts learned in an active student error correction procedure to believe that children who are able to internalize and digest the information to be learned during and after instruction display an essential ingredient towards successful learning.

The question "Are all people created equal?" surfaced at the conclusion of this project. Can we really look for answers that will fit the needs of all students? We need to look at individual differences and circumstances when truly evaluating the outcome to describe the hows and whys things are the way they are. How much active participation is necessary for an individual to be able to internalize the information that is being introduced and recall the most from the experience? How are we, as concerned educators, to offer students the most productive learning environment to meet their individual needs?

Students who become responsible for their own learning, will learn the most and develop into wholesome, self-confident individuals. To become an active responsible learner, the classroom experiences for our children should encourage less instruction where the teacher talks and the student listens and more instruction where the teacher

models the appropriate outcome so that the student learns how to actively utilize this information in many areas in school and in life. Learning should begin with what the student already knows and enhance the knowledge-base from there. Every student, regardless of their strengths or weaknesses, should have a program of learning that matches their individual needs. This may not be feasible with the present conditions in our school system but it's time to become aware that all students are capable of learning what is necessary for their own growth. Our schools should be preparing children to be responsible from the beginning of their educational experiences for their own future.

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