DIFFERENTIAL EFFECTS OF HAND RAISING AND
RESPONSE CARDS ON RATE AND ACCURACY OF
ACTIVE STUDENT RESPONSE AND
ACADEMIC ACHIEVEMENT BY
AT RISK AND NON AT RISK STUDENTS DURING
LARGE GROUP 5th GRADE SCIENCE INSTRUCTION

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

by

Ralph Gardner, III, B.S., M.A.

* * * * *

The Ohio State University

1989

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Advisor

College of Education
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Ralph Gardner, III
1989
"LORD, thou hast been our dwelling place in all generations."
Psalm 90:1

Dedicated to my parents,

Ralph and Helen Gardner
ACKNOWLEDGEMENTS

I would like to express my gratitude to my wife, Joanne, for her support and love. I would also like to thank my children (Anika, Ralph, and E’yen) for their patience and understanding.

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PUBLICATIONS


Gardner, R. III. (in press). "Life space interviewing: it can be effective, but don't...". Behavioral Disorders.


Gardner, R. III. (1988). Building better relationships: A sourcebook of activities for developing social skills. Franklin County Residential Services. Franklin County Board of Mental Retardation and Developmentally Disabled.

FIELDS OF STUDY

Major Field: Applied Behavior Analysis
Mildly Handicapped
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CHAPTER 1

INTRODUCTION

Recently there has been increased interest in the early identification of students at risk of dropping out of the educational system (Ekstrom, Goertz, Pollack, & Rock, 1986; Hall & Keogh, 1978; Lloyd, 1978). The drop out rate has been viewed as a serious problem for a long time, due to the correlation between failing to complete high school and the limited economic opportunities available to most dropouts throughout their lives (Rumberger, 1987). Large numbers of students dropping out of school also has societal ramifications, such as loss of tax revenues, a greater burden on social agencies, and increased crime rates (Rumberger, 1987).

Researchers have become interested in the role schools play in what becomes a destructive cycle for some students. In comparison to other students, dropouts generally score lower on
school tests, have poorer grades, and are more likely to have
disciplinary problems (Wehlage & Rutter, 1986). Wehlage and
Rutter conclude that "given this rather negative set of experiences it
is not surprising that students leave school for a different
environment" (1986, p. 381).

Do schools in fact contribute to the problem and can they take
preventive measures? Students at risk of dropping out are more
likely to live in low socioeconomic neighborhoods (Ekstrom, et. al.
1986). The academic problems of students in the inner cities are
often attributed to the environment (Carta & Greenwood, 1988).
Relatively little emphasis has been given to the fact that the
instructional methods used by teachers can make a significant
difference in the academic performance of at risk children, despite
the fact that research has shown a correlation between teacher-
student interactions and academic development (Brophy, 1979;
Good & Grouws, 1979). Further, it has been shown that there is a
functional relationship between the time students are academically
engaged and their academic performance (Greenwood, Delquadri, &
The idea that students learn more effectively "by doing" is not new. In 1916 John Dewey advocated active student response as a way to help students improve their skills. Bloom (1980) pointed out that the teacher has control over the amount of time that the students are actively engaged in academic responding. Skinner (1984) has also noted the need for teachers to use classroom time more effectively. Carta and Greenwood (1988) found that community and home educational disadvantages for children from the inner city could be overcome: that the level of academic achievements for various types of students was most impacted by the quality and amount of instruction. Carta and Greenwood found the most important factor for academic achievement was the extent to which students were academically engaged during the instructional presentation. The greater the active engagement of the student during the learning process, the greater the academic achievement.
Researchers have found that opportunity to respond (OTR) for inner city children is less than that for their suburban counterparts (Greenwood, Delquadri, Stanley, Terry, & Hall, 1985). The important finding was that lower frequency of academic behavior was not related to the student's level of intelligence or socioeconomic status, but to the way instruction was presented by the teacher (Carta et al., 1988). Once it is recognized that the most significant factor affecting academic achievement is not socioeconomic status, the community environment, or home environment, but the quantity and quality of instruction, educators can expend our energies using and developing instructional technologies that actively engage students in academic responding.

One tactic for increasing the academic responding of students during group instruction is the use of response cards (Narayan, 1988; Wheatly, 1986). Response cards are reusable cards which students may hold up to reveal their response to instructional stimuli. There are two basic types of response cards: write-on and preprinted. A write-on response card allows the student to write
and erase short answers on the card. Preprinted response cards permit the learner to select from a pool of answers a response to the instructional stimulus, with all questions having the potential to be correctly responded to by one of the preprinted answers. Response cards give each student in the class the opportunity to respond to each question or problem presented by the teacher, as opposed to only the student who is called upon by the teacher responding, as with the traditional hand raising method. Response cards also provide the teacher with direct, continuous feedback about what the students are obtaining from instruction. Response cards permit an increased opportunity for the teacher to give students appropriate feedback on their responses.

**Purpose of Study**

This study was conducted for several reasons. First, the study was an attempt to systematically replicate the effects of previous research by Narayan (1988), who used response cards in a fourth grade social studies class and found that they increased the active student responding, improved the group mean score on daily
quizzes, and was preferred by students as a way of responding.
Second, this study differed from the Narayan study in that it: (a) analyze any differential effects of type of student responding (i.e., response cards and one-at-a-time hand raising) on the quizzes taken a minimum of 24 hours after instruction has occurred, (b) used bi-weekly unit tests to evaluate whether response cards produce improved performance on cumulative review tests, and (c) was conducted in a different grade level (fifth grade) and with a different subject (science) matter. Three, to examine the methods of student responding with regard to it's relationship to the academic achievement of the at risk and non at risk students.

Research Questions

The study was designed to produce empirical data in response to the following questions:

1. What method of student responding, hand raising or response cards, produces the highest frequency of active student response during instruction? Does the active student response rate of at risk students vary as a function of the student response
method used?

2. What method of student responding, hand raising or response cards, produces the highest accuracy responses of students during instruction?

3. What is the rate per minute of teacher presented learning trials with each method of student responding?

4. What method of student responding, hand raising or response cards, produces the highest scores by 5th grade students on science quizzes administered the next day after instruction? Specifically, do the quiz scores of at risk students vary as a function of the student response method used?

5. Is there a relationship between the type of quiz question (recall or recognition) students answer correctly on the daily quiz and the mode of student responding used during instruction?

6. Is there a difference in the number of items students answer correctly on unit tests, at the end of a 2-week instruction period, as a function of the mode of student responding?
7. Is there a relationship between the type of question the student is able to answer correctly (recall or recognition) on 2-week unit test and the mode of student responding in effect during content instruction?

8. Is the most effective mode of student responding the same for at risk students as it is for the non at risk students?

9. When asked their opinions after the study, which methods of responding will the students prefer, hand raising or response cards?

**Terminology**

All special terms used in this study are defined below.

**At risk:** At risk students were judged by their teacher as being in danger of failing academically and/or being considered for a special education placement due to poor grade point average, performance on standardized tests, and general response to the expectations of the school.

**Cover sheet:** Cover sheets were 8 1/2" x 11" plain yellow papers. These sheets were used by students to cover their answers
during quizzes and unit tests.

**Daily quiz:** Daily quizzes consisted of 16 items covering information from the previous session. The first eight questions (1-8) were recall questions requiring students to write one or two word responses to the answer the question correctly. The last eight questions (9-16) were recognition questions requiring students to write their selected response taken from four choices or to determine whether a statement is true or false.

**Demonstration:** The demonstrations were illustrations of scientific principles being taught in lecture. For example, in teaching about the refraction of light, a prism was used by the teacher to refract light into its various color components. Demonstrations were brief, lasting 1 to 2 minutes, and performed so that all the students could experience the same phenomenon at the same time.

**Dry marker:** Dry markers ("Expo") were used by students to write on the write-on response cards. The marks made using this marker could be erased easily by rubbing lightly with a facial
Hand raising: Hand raising was when student responded to the teacher's questions by raising their hand in the air above their heads and holding it there until the teacher called upon a student to answer the question.

Instructional transparencies: Transparencies were made from lecture outlines, the transparencies included all of the facts/concepts to be instructed during the lesson. Each lecture had from 3 to 4 instructional transparencies. The transparencies were made using water soluble markers. A different color marker was used to underline key words or phases as the teacher lectured.

Lecture Outline: Lecture outlines included 18-22 main ideas or concepts/facts for the teacher to present during the lecture to the class.

Non at risk: Non at risk students were students judged by the teacher to be in no danger of academic difficulties based on their grade point average, performance on standardized tests and current level of classroom performance. These were students who were
meeting the expectations of the school and classroom.

**Progressive disclosure:** Using a sheet of paper to progressively uncover and disclose each key concept or fact on the overhead transparency as it was being discussed by the teacher.

**Rate of student response:** The rate of student response was the number of times that a student attempts to answer the teacher posed question using the student response mode in effect for that session.

**Rate of student correct responses:** The number of times the student was correct when responding to the teacher posed question using the student response mode in effect for that session.

**Student preference and opinion:** The students were individually read an questionnaire asking their preferred mode of student responding and their opinion about the instruction they received.

**Teacher preference and opinion:** The teacher was given the same questionnaire to read and write her responses to the questions.
**Teacher presentation time:** The time of each lecture and review of presented information was kept using a stopwatch.

**Systematic disclosure:** Systematic disclosure is the process by which the teacher used a separate paper (8 1/2" x 11") to cover the transparency so only the information currently being presented in the lesson or test was showing.

**Unit test:** The unit tests occurred every 2 weeks and covered the material presented during that time period. Unit tests consisted of 40 questions, 20 recall and 20 recognition questions. The recall and recognition questions were presented in an alternating format, with each question being read out loud twice.

**Write-on response cards:** Write-on response cards were 9" x 12" white particle boards on which each student wrote on in response to teacher questions. Dry markers were used to write his/her cards. Once the teacher had reviewed the students' answers by simultaneously having the students hold up their cards, the students were instructed to erase their answers.
CHAPTER II

REVIEW OF THE LITERATURE

This chapter reviews the literature on the academic achievement of educational at risk students and programs designed to improve their academic performance. Also reviewed is a growing body of research literature demonstrating the relationship between increased active engagement by students during instruction and academic achievement.

At Risk Students

The defining characteristics of the "at risk" student changes depending on who is doing the defining. Colleges and universities define "at risk" students as those who may be unable to pursue higher education due to lack of finances. High schools often term students "at risk" due to their potential for dropping out of school. Counselors often talk about students being "at risk" for drug or alcohol abuse. The term "at risk", as it was used in this study, refers to students who are: 1) doing so poorly in their academic
work that they are in danger of failing academically, 2) being
referred for special education placement, and/or 3) demonstrating
behavior patterns associated with people who tend to dropout of
school.

Characteristics of At Risk Students

Much of the current literature in the area of academically at
risk students focuses on trying to identify the at risk student as
early as possible. Lloyd (1978) claims that key variables that can
be identified as early as the third grade as predictors of students
dropping out of school. The literature on at risk students is
primarily descriptive in nature and focuses largely on potential
high school dropouts and the associated social problems (e.g., loss
of tax revenues, bigger burden on social agencies). This concern
about the associated social problems is particularly centered around
inner city schools, some of which are reporting dropout rates as
high as 40-50 percent (Wehlage & Rutter, 1986). People without a
high school diploma generally are unprepared for the work world
and often must accept the most menial jobs if they are
to be employed at all.

Educators are trying to help potential drop outs before they actually leave school. Rumberger (1987) states that it is more likely that a dropout prevention program will be successful if "at risk" students are identified early. He has identified five clusters of factors associated with at risk students: demographic, peer-related, school-related, economic, and individual.

Demographic factors. Differential dropout rates have been found among students of different racial backgrounds. Ekstrom et al (1986) contracted with the National Center for Educational Statistics (NCES) to conduct a study using NCES's High School and Beyond (HS&B) data base. The HS&B was a national longitudinal study tracking the growth and development, of approximately 30,000 1980 high school sophomores attending 1,105 public and private secondary schools nationwide, to their school experience over the period 1980-1982. During their analysis of the HS&B data, Ekstrom et al collected data on over 2,200 of these students who were seniors in 1982 and over 2,000 individuals who had dropped
out of school by 1982. They found that Hispanic and African-American students are more likely to dropout of school than white students, with the Hispanic students having the highest dropout rates. Ekstrom et al. reported a dropout rate of 27% for Hispanic, 19% for black students, and 14% for white students. Approximately 40% of the Hispanic students who eventually dropout of school report that they did so because of economic reasons. Southern whites are more likely to dropout of school than whites from other regions; however, southern blacks are less likely than blacks in other regions to leave school prior to completing high school (Ekstrom et al., 1986). Statistics indicate a nationwide increase in the dropout rate among white, middle class youth (Rumberger, 1983).

Whelage and Rutter (1986) also analyzed the HS&B data using a random sample of 40% of the students who had filled out a questionnaire in both 1980 and 1982. They concluded that when the family background factor is controlled, race is not a factor that can predict dropouts. Whelage and Rutter claim that family background
characterized by low socioeconomic status (SES) is a variable that is strongly linked with dropouts. Students from low SES families have a 25% dropout rate, compared to students from middle SES families who dropout at a rate of 13%. Students from high SES have the lowest dropout rate at 8% (Ekstrom et al., 1986).

Rumberger (1987), in his analysis of data from the U.S. Department of the Census, School Enrollment, found that males have a slightly increased likelihood of dropping out (16%) in comparison to females (14%). In an earlier study Rumberger (1983) examined a national sample of youth who were 14 to 21 years old in 1979. One of his findings was that females, in particular black females, name marriage and pregnancy as reasons for leaving schools. Male dropouts often state their dislike for school as the reason for leaving school early (Perrella & Bogan, 1964; Rumberger, 1983).

**Family related factors.** Rumberger (1983) states that family background is a strong predictor of whether or not a student will dropout of school. Families headed by a single parent, households where English is not the spoken language and parents with little
formal education are all indicators of a greater risk of dropping out of school. In the same study, Rumberger also found the more reading material in the home the less likely the student would be at risk of dropping out.

Rumberger (1983) found white children from large families are at greater risk of dropping out than white children from small families, but the family size as a factor does not hold true for minorities.

Shaw (1982) examined data from the National Longitudinal Surveys of Labor Market Experience (NLS). Her sample was made up of families in which the mother was interviewed in the Survey of Mature Women and the daughter answered questions in the Survey of Young Women. Given the increase in children in single parent homes in the country, Shaw analyzed the effects of a student living in a single-parent family on the high school completion of young women after statistically controlling for family income. Shaw found that for black females both variables living in a home with a single parent and low family income independently contribute to
dropping out of school prior to graduation. This finding did not hold true for white females, for whom it was found that living in a single parent household has no effect on graduation once the generally low income was taken into account.

Shaw also found a correlation between the academic level of the parent and the likelihood of the child being at risk: daughters of white mothers who have not completed high school were at increased risk over other white females from single parent homes whose mothers had finished high school. According to Shaw, black females' educational attainment is not similarly impacted by whether the mother has or has not completed high school.

Solomon, Hirsch, Scheinfeld and Jackson (1972) and later Shade (1978) found no significant correlation between student achievement and "father" absence in the home. Solomon et al. (1972) collected data on 149 students in a west side Chicago black ghetto using fifth grade students as subjects during the academic year of 1964-65, a generation ago. The families in the study reported an average annual income of $4,860 (compared to a city
average of $6,791 in 1960). Solomon et al. found that the smaller
the family size the better the school performance of the student.
While the first born children in families with four or five siblings
may do poorly academically because they have been given many of
the caretaking responsibilities for the younger children. Solomon et
al. suggest the younger children in large families do better
academically because they do not have the same child care
responsibilities as their older siblings.

Shade's (1978) study of black academic achievers and their
families, suggested that the difference between the achievers and
nonachievers (as measured by standarized tests) is not the
occupation and income of the family but the difference in the
family's view of the world. Shade suggested that the most
important difference between black achievers and black non
achievers is the behavior of the parents: "Parents of achievers tend
to be warm, accepting, supportive, and at the same time demanding
86). Shade further states the families of black achievers tend to
viewed the world similar to higher income groups.

Hill (1979) examined data from the National Longitudinal Survey of Young Men (NLSYM) his sample consisting of the young men from 14 to 17 years of age and enrolled in high school in 1966. Hill analyzed the data from the point view of a person concerned about the future labor force in the country. He found that the larger the family size the greater the likelihood the student would drop out. Also, that there was a correlation between the education obtained by the parent and whether the student completed high school.

Peer related factors. Orr (1987) suggested some students might be dropping out of school due to peer pressure. He discusses the possibility that students who have dropped out of school and have a source of income may be an incentive to other students to dropout of school. This idea of a peer related factor has not been researched enough to make clear statements about it at this point (Rumberger, 1987).
School related factors. Orr (1987) listed several school factors that correlate with later dropping out, such as absenteeism, truancy, dislike for school, transferring from one school to another, and failure to be promoted to the next grade. Natriello, McDill, and Pallar (1985) examined various available data bases concerning dropouts including the: National Testing Service’s Study of Academic Predication and Growth, a national survey of school administrators, National Commission on Excellence (Sims, 1984), and a report from the American Educational Research Association. Natreillo et al. (1985) found students performing at 1 to 2 years below grade level are at an increased risk to dropout of school as compared with students who are performing at or above grade level academically.

Hall and Keogh (1978) reported findings from a 4 year longitudinal study evaluating at risk and non at risk students. Their study included 60 students from a pool of 100 urban kindergarten children from a low-to-middle SES area. There were 30 students determined to be at risk based on behavior observations and
teacher ratings, another 30 students were identified as non at risk
target students. Two of the factors used to determine the students' status of at risk or non at risk were performance on academic
assessment tests and age appropriateness of social skills. At risk students were reported to have more difficulty interacting with peers both in the classroom and on the playground, and reportedly they were less liked by their non at risk peers. Academically the at risk students were found to be more distractable during tasks with low adaptability. Hall and Keogh did note that while these are general characteristics of the at risk population, any group of at risk students includes individuals with a wide variety of skills and abilities.

Wehlage and Rutter (1986) studied the data from four national longitudinal studies: Project TALENT (Flanagan, Davis, Dailey, Shaycoft, Orr, Goldberg, & Neyman, 1964), Youth in Transition (Johnston, 1973), National Longitudinal Survey of Youth Labor Market Experience (Kim, 1982), and High School and Beyond (Fetters, Brown, & Owings, 1984). Wehlage and Rutter found a
strong correlation between family background, low SES and dropping out of school. They found low grades and course failure is associated with dropping out. At risk students also tend to have higher rates of discipline problems and a greater frequency of tardiness (Wehlage & Rutter, 1986). The discipline problems students experience in schools imply according to Wehlage and Rutter that the school itself may contribute to negative experiences leading to dropouts.

Fine (1986) talked directly with New York City black and Hispanic teenagers, who had dropped out of school and those who decided to stay in school about the reasons for their decisions. Dropouts reported leaving school due to a dislike of the oppressive teaching style of some teachers, problems within the home, the need to earn money, and some indicated that they did not dropout but were thrown out of he school by school personnel. Fine reports that the practice of "cleansing the school" of the bad element is a common but officially unrecognized practice. Fine also found that many students who dropped out of school attended schools with
poor facilities and less than adequate teaching staffs.

**Academic failures and excessive absences in elementary school** are the most effective variables in predicting later high school dropouts according to Stroup and Robins (1972). Stroup and Robins examined the elementary school records of 223 black urban males for predictors of high school dropouts. In addition to the academic failures and absences as early predictors of at risk students school retention, early drinking, parental social status, and the number of schools attended was also associated with dropping out.

**Economic factors.** Students from lower socioeconomic status families are more likely to drop out of school than are children from other socioeconomic levels (Ekstrom et al., 1986; Natriello, McDill, & Pallas, 1985; Rumberger, 1983). Yet many students from low socioeconomic status families are successful in the educational system. Shade (1978) indicated that within black lower socioeconomic status families there are differences in characteristics between families producing achievers and those producing
nonachievers. While family income was low the parents of the academic achievers tended to hold clerical, semiskilled, or skilled jobs with a lower percentage unemployed or on welfare as compared to the nonachievers' families. Further, these parents tended to be more supportive of academic activities, they provided more structured and cared for homes and better study facilities for their children (Greenberg & Davidson, 1972).

Another economic reason for dropping out is students at risk of dropping out are more likely to hold a job and enjoy that job more than school than their non at risk peers (Ekstrom et al., 1986).

Individual. Students who dropout of school report having low levels of self-esteem and express a sense of no control of their lives more than other children (Rumberger, 1987). Students who dropout often do not enjoy school and have low educational and occupational goals (Wehlage & Rutter, 1986). For example, an at risk students' occupational goal may be to work as a nurse's aide in a hospital compared to the non at risk student's goal to be a nurse.
Special education placement. Special educators have become increasingly concerned about the current push for "excellence" in education, and the effects of this movement on children already in special education as well as the low achievers in regular classrooms (Sapon-Shevin, 1987; Shepard, 1987). Their concern grows out of the fact that poor academic performance in school is usually an initial step of the special education selection process (Chalfant, 1984). Chalfant also states "while academic failure is often attributed to characteristics of the learners, current achievement also reflects the opportunities available to learn in school" (1984, p. 11). Reschly (1988) noted that special education is often viewed as the only option for low achieving students.

Heller, Holtzman, and Messick (1982), in their National Academy of Sciences panel report on the selection process for exceptional students, felt that a variety of remedial options in regular education should be in place for students experiencing academic difficulty. Prereferral intervention systems which provide service and assistance in the regular education classroom to
students who are at risk of being placed in special education
classroom results of this consultant model was a positive decrease
in four of the six schools in which the program was implemented
(Gradon, Casey, & Bonstrom, 1988). The use of the prereferral
programs may resolve a significant portion of the learning and
behavior problems that lead to special education referral (Reschly,
1988). By addressing problems of academically at risk students in
the regular education classroom, some students might be able to
become successful in the regular class and not be stigmatized by
placement in special education.

Some educators even advocate the elimination of all special
education and the instruction of all students in regular classrooms.
In pushing for the elimination of special classes, Stainback &
Stainback (1987) suggest that all teachers be trained in a variety of
effective instructional skills in order to service all learners.

Programs to Assist Academically At Risk Students

Educators have developed a variety of programs to help at
risk students in the regular classroom (Becker, 1977; Boehnlein,
Wehlage, Rutter, and Turnbaugh (1987) advocated an autonomous faculty with a low pupil-to-teacher ratio and a caring environment as a way to help at risk high school students. The New York City Schools instituted a program called Dropout Prevention Initiative (DPI) involving tangible rewards for at risk students who remained in school (Gerics & Westheimer, 1988). As a part of this New York City School Board adopted a set of criteria for identifying students at risk of dropping out of school, the criteria consisted of poor school attendance, poor grades, and frequently cutting classes. Once identified as at risk, students were then eligible for a variety of dropout prevention services, attendance outreach, additional guidance and counseling services, additional health services, alternative education programs, and improved school services.

Attendance outreach south to improve the at risk student's school attendance through increased contact with the parents via phones calls, letters, home visits, and some early morning wake-up calls.
DPI used rewards such as: T-shirts, calculators, bookbags, and hats for students who meet the criteria of perfect attendance for a month. There was also another category of rewards for meeting the attendance criteria; these rewards ranged from Broadway plays to neighborhood excursions. Once the students were in school they were provided extra counseling to identify and address existing and potential problems. Additional health services involved both screening for physical and psychological problems. The primary educational component of the DPI was a vocational education program. Gerics and Westheimer do not provide any empirical data on the program's outcomes. However, anecdotal information indicated that both the school personnel and the at risk students felt the project was beneficial to preventing dropouts. Gerics and Westheimer did suggest the alternative education component of the program may limit the students' future career opportunities.

Educators in Patterson, New Jersey saw a similar pattern of poor urban youth falling behind their peers academically with large numbers of students already identified as needing special education
(Williams, 1987). In an effort to reverse this trend, a plan was developed to teach thinking skills to students beginning in kindergarten. The Cognitive Instruction Project (CIP) was implemented throughout the district in the elementary schools. CIP involved cooperation from administrators, teachers, and parents. For example kindergarten students were taught to recognize and reproduce patterns of multi-colored blocks in the schools then the parents would then work on the similar skills in the home.

Teachers systematically taught problem solving skills at each grade level and in each course. Students in the CIP program performed better on the California Achievement Test than their peers who had not been enrolled in the program.

A similar plan involving teaching low functioning, LD students task-specific learning strategies that would help them generalize the learning skills to a variety of environments was reported by Deshler and Schumaker (1986). The first step is to determine the types of curriculum demands that are causing the student to fail (e.g., taking notes or writing sentences). This information is then
used to develop the task specific strategy to be taught to the student. The skills and then broken down and discussed with the student. The student with guidance sets realistic goals for mastering the strategy. Deshler and Schumaker report that the learning strategy is very effective for helping students to improve needed skills. They view the development of learning skills was viewed as particularly important for the student making the transfer from elementary to middle school.

Levin (1987) proposed a plan of accelerated schools for disadvantaged students designed to close the achievement gap by the end of the sixth grade. Levin and the Stanford group's Accelerated School proposed the development of individualized educational plans with a strong emphasis on the language arts.

Educators in Ohio put together a intensive reading program for first graders who were experiencing difficulty reading (Boehnlein, 1987). The Ohio Reading Recovery program took the highest risk students for one-on-one reading lessons. Students practice reading and rereading many easy books with interesting
stories. Students are given opportunities to write sentences and short stories and receive instructional feedback, on their efforts. Independent reading strategies are developed by the students to enable them to learn in their regular classrooms. After 30 to 40 hours of this intensive instruction, researchers reported that 90% of the students catch up to or pass the class mean in reading and never need additional remediation. At risk students enrolled in the Reading recovery program not only made more progress than other at risk students but, they improved at a rate greater than the students not at risk. Follow-up studies indicate that the gains made by the students in the Reading Recovery program are maintained from year to year (Pinnell, 1986).

The Adaptive Learning Environments Model (ALEM) was implemented in New York City Schools during the 1982-83 school year (Wang, Rubenstein, & Reynolds, 1985). ALEM was designed for regular education classes with mainstreamed special education students. ALEM was set-up to meet the needs of all students in the classroom. The program was highly successful in helping the low
functioning students improve their skills at a accelerated rate. The ability to help students who may be experiencing difficulty in the regular classroom is important to special educators because of their desire to mainstream special learners and help struggling students before they are identified as needing special education. One important strategy for helping students improve academically is increasing their level of active academic responding during instruction.

Summary

The term "academically at risk" refers to a student who is doing so poorly in his/her school work that he or she is in danger of failing academically, or being referred to special education, or is showing a pattern of behavior associated with people who tend to drop out of school. Statistics on school dropouts reveal that the strongest predictors for dropping out of school are the family's background and socioeconomic status.

Low academic performance is a vital step in the identification of the at risk students for special education referral.
Educators are seeking preventive strategies to help students in the regular classroom who are at risk of being placed in special education.

The accurate identification and intervention strategies to help academically at risk students is important to both regular educators as well as special educators. Practical options to help low functioning students need to be available for regular educators. The options should offer increased opportunities for at risk students without being detrimental to the non at risk student, or unduly punishing the teacher with excessive work. These options should include instructional strategies that can be used in a variety of situations.

**Opportunity to Respond and Academic Achievement**

Increasing students' time on task has been shown to be an effective way to improve academic performance in classroom settings (Bloom, 1974; Stallings, 1980). Increasing the opportunities for students to respond is an important instructional strategy to help students improve their academic skills.
Researchers in an effort to increase the rate and duration of academic responding have become more interested in the entire learning environment using an eco-behavioral view toward education (Greenwood, Delquadri, & Hall, 1984).

An eco-behavioral approach to education involves analyzing the interactions based on the three term contingency of antecedent-behavior-consequence. Much of the initial research in this area was done at Juniper Gardens Children's Project, where researchers were concerned about improving the academic skills of at risk students from an disadvantaged environment. There was a great deal of concern as researchers began to closely examine the school environment and found some students were spending as little as 5 seconds per day practicing basic math skills (Hall, Delquadri, Harris, 1977). Students in the most need of reading instruction received little or no time reading orally (Hall, Delquadri, Greenwood, & Thurston, 1982). It became evident there was a need to increase the opportunities for students to respond.
**Direct Instruction**

Meyer (1984) found that the direct instruction approach increased children's opportunities to response and resulted in better academics scores and better self concept evaluations for the students. A defining feature of direct instruction is increased academic responding from the students. This use of direct instruction was shown to be beneficial to the academic achievement of disadvantaged students in reading and language skills (Becker, 1977). Project Follow Through demonstrated the superiority of the direct instruction model over other models both in academic gains by the students and in their improved self image. Students who participated in direct instruction during their early elementary school years were also found to have long term benefits from direct instruction shown by higher scores on standarized tests in high school, lower rate of dropping out, and a higher rate of applying to colleges than students who had not received direct instruction in elementary school (Gersten & Keating, 1987). Gersten and Keating found these positive long term benefits of direct instruction in
studying the first two classes of students who had participated in the Follow Through Project as they completed high school in 1981 and 1982 respectively.

Positive findings using direct instruction were again seen in teaching reading comprehension skills to students (Duffelmeyer & Baum, 1987). Duffelmeyer and Baum describe how teachers help students to learn the comprehension skills by teaching them what the skill is, for instance "main idea" and giving them strategies to identify the skill. The teacher then provided additional time for the students to apply the strategy. The direct instruction paradigm of demonstration, guided practice, and independent practice seems to provides the redundancy and clear examples to aid students in learning.

**Academic Learning Time**

The concept of Academic Learning Time (ALT) originated from the Beginning Teacher Evaluation Study (BTES) (Berliner, 1979). ALT is defined as "engaged time with materials or activities that produce a high success rate and are related to the outcome
measures being used" (Berliner, 1980 p. 305). The researchers focused on the academic progress of students in math and reading instruction. The desire was to identify those teaching activities that enhance student achievement. One example of ALT is a systematic program structure where each student is given a set of academic activities which are posted publicly; these activities reinforce the small group activities and are easy to complete (Kramer, 1987).

Opportunity to Respond

Opportunity to Respond (OTR) and ALT are similar in that both focus on student activities during instruction and are concerned about increasing the amount of time the student is engaged in academic tasks. There are also differences between OTR and ALT. ALT is more general as does not qualify the type of student behavior except to say that the student should have a high rate of success. OTR emphasizes the frequency of student responding to the instructional stimulus so the teacher can provide corrective feedback and social praise.
Research has shown a clear relationship between the opportunity to respond and academic achievement (Delquadri, Greenwood, Stretton, & Hall, 1983; Pratton & Hales, 1986). Opportunity to respond is defined "as the interaction between: (a) teacher formulated instructional antecedent stimuli (the materials presented, prompts, questions asked, signals to respond, etc.), and (b) their success in establishing the academic responding desired or implied by the materials." (Greenwood, Delquadri, & Hall, 1984, p. 64).

Delquadri, Greenwood, Stretton, and Hall (1983) used a peer tutoring spelling game to increase the opportunities to respond for students. Delquadri et al. then examined the results of the peer tutoring on 24 third grade students' performance on weekly spelling tests. Low functioning students went from a mean of 9.0 errors on the 18 weekly words to a mean of 2.5 errors with the OTR strategy. The average students also benefited from OTR going from a mean of 3.0 errors during baseline to .5 during the peer tutoring.
Strategies for Increasing OTR

Numerous strategies for increasing OTR have been described in the research literature, including: choral responding (Heward, Courson, & Narayan, 1989; Sindelar, Bursuck, & Halle, 1986), peer tutoring, (Cooke, Heron, & Heward, 1983; Pigott, Fantuzzo, & Clement, 1986), learning centers (Wendelin, 1984), computer assisted instruction (Calvert, Watson, Brinkley, & Bordeaux, 1989), guided notes and structured worksheets (Courson, 1989; Kline, 1986), timed trials (Van Houton, 1980), and response cards (Narayan, 1988).

Three strategies that appear especially promising for increasing the effectiveness of teacher led large group instruction are guided notes, choral responding, and response cards. Guided notes are written handouts which enables students to follow along during an instructional presentation providing cues to note important points as well as basic information. Structured worksheets are handouts or sheets with a series of items that are completed as the presentation progresses. Choral responding allows
all the students to respond orally at the same time rather than the traditional way in which the teacher calls upon one student at a time to respond. Response cards are reusable signs or cards which can be held up by each student in the class to indicate his or her answer. Response cards can be pre-printed with responses (e.g., Yes or No) or write-on response cards on which the student writes his or her answer to the question.

Guided notes. Guided notes are described as a handout that "guides" the student through the material to be covered by the teacher. Guided notes help set the occasion for the student to write in key concepts, facts, and relationships (Heward, Courson, Narayan, Kline, Wheatley, & Heron, 1988). Guided notes include basic information and gives the student cues for writing in the key facts, and concepts and/or relationships.

The ability to take effective notes on teacher presented information is often required in classes (Fowler, 1985). Students who take notes in classes and subsequently study their notes tend to do better academically then students who just listen and read the
text book (Baker & Lombardi, 1985; Smith, 1984). Teaching note taking skills directly is recommended during the elementary school years (Schilling, 1984).

Lovitt, Rudsit, Jenkins, Pious, & Benedetti (1985) used Precision Teaching (PT) and Study Guide (SG) methods of science instruction for 7th grade students both LD and regular education students. They specifically designed "see-to-say" and "see-to-write" practice sheets were used with Study Guide sheets which they termed "framed outlines". The PT approach featured the words and definitions in each chapter that were considered important by the teacher. The see-to-write Precision Teaching practice sheet was a fill-in the blank, short answer format on which the student practiced writing answers based on material from the science book. The students in the PT and SG groups performed better on the posttest than the students taught using other methods.

Kline (1986) compared the method of students taking their own notes with that of the teacher providing the students with guided notes, during American history instruction. Ten LD students
were the subjects and the target behavior was each students’ scores on daily 10-item quizzes. Baseline consisted of the students taking their own notes during the class lecture. The guided notes were used in the intervention phase. During the baseline phases the class mean scores were 62% and 68% as compared to class mean scores of 92% and 91% when guided notes were used.

In another study (Heward, Courson, Narayan, & Kline, 1987), using 11 LD students the effects of guided notes and teacher-completed notes were compared. The students were in a United States Government class. An alternating treatment design was used. Baseline conditions consisted of students taking their own notes. One intervention phase involved the use of guided notes. The other intervention phase involved teacher completed notes. Students were given 3 minutes to study their notes before taking a 10-item quiz. Results showed that mean scores during the guided notes phase were the highest of the three phases. Under baseline conditions the students mean score was 5.8, with teacher completed notes the mean was 8.0, and with guided notes the mean score was
8.2 correct responses.

Yang (1988) conducted a study using guided notes in a sixth grade class during in science instruction. There were 23 students in the regular education class of which 5 were mainstreamed LD students. Yang found that when guided notes were used the students performed better on the 10-item quizzes.

Pados (1989) compared the effects of guided notes and students' own notes on daily quiz performance of 20 fifth-grade students in American history. There were 7 gifted students and two LD students in the class. Guided notes provided higher scores for students than when they took their own notes during baseline conditions. The LD students went from a mean score of 64% in baseline conditions to a mean score of 93% under guided notes conditions. The gifted and talent students mean score during baseline was 84% and during guided notes 92%. The regular students scored went from 64% under baseline conditions to 86% under guided notes conditions.
Courson (1989) used guided notes in a seventh grade social studies class in a suburban public middle school. There were 19 students in this class, 8 who had been identified as LD and 11 as academically at risk. Courson used a multiple treatment reversal design to compare the effects of long-form guided notes, the short-form guided notes, and students taking notes on their own. Long form guided notes required the students to write the important concept in the form of a sentence. Short form guided notes required the students to fill in the blanks with a word or a phrase. Results indicated that the guided notes made a significant difference in increasing the scores on the daily quizzes. At risk students had a mean of 4.8 correct answers on the 10 item quizzes when using their own notes. The at risk students correct rate using short-form guided notes had a mean of 8.5. Using the long-form guided notes the students had a mean rate of 8.9 correct responses.

**Choral responding.** When choral responding all students in the class respond in unison orally to teacher posed questions. Choral responding was successfully used to teach mildly
handicapped elementary students sight words (Sindelar, et al., 1986). Subjects consisted of 11 elementary LD and DH students. Instruction took place in small groups of three or four students. During the ordered sequence the instructor called on the students moving from right to left in sequence. When the students used choral responding during instruction they learned more words. On average, there was an increase of 4 more correct responses on the posttest as compared to posttest scores when each student took a turn responding (ordered responding) to the instructional stimulus.

Non-verbal choral responding was used by McKenzie and Henry (1979) to evaluate student responding to teacher questions. Students responded to teacher questions by raising their hands or by pointing at an object. The results showed an increase in on-task behavior as well as in academic performance. Students in the in-unison group averaged 28 items correct on a 30 item posttest, as compared with 19.6 for the individual response group.

Choral responding can increase the active student responding for all students in a class. It is also very cost effective and easily
used in most teaching environments.

**Response cards.** Response cards are reusable cards, boards, small chalk boards, signs, or other things that students can hold up to display their responses to teacher presented questions. Response cards enable each student in the class to respond to each teacher question. The teacher looks at each student's card to determine if his/her response is correct. The teacher then can give appropriate feedback to the students. Response cards provide an opportunity to the teacher to discern whether or not the students can answer questions correctly about the information being instructed.

There are two basic types of response cards write-on and pre-printed. Write-on response cards enable each student to write then erase their response to the teacher's question. Write-on response card may be a small notebook size slate that a student would use a piece of chalk to write responses. Another example of a write-on response card would be a laminated particle board on which a student would write using a dry marker. Write-on response cards enable students to make responses to both recognition and recall
type questions. The responses to questions are generally restricted to one or two word answers and it takes extra time for students to respond due to the student writing then erasing answers. Write-on response cards still enable the students to have many more responses than the traditional hand raising method.

Pre-printed cards have a pool of possible answers to questions already printed on them. Each student then selects an answer to the teacher’s question from the pool. Pre-printed response cards allows rapid questioning (Narayan, 1988). Pre-printed response cards only allow recognition type questions to be asked. Pre-printed response cards can be made out of a variety of materials, most often they are made of poster board or cardboard. The teacher will have decided prior to the lesson what are the available responses needed for the student to appropriately participate in the planned lesson. Often the types of responses used are “True or False”, “Yes or No”, or specific names for the particular content area such as names of planets. The rate of student responding using pre-printed response cards is usually more rapid
then when hand raising or write-on response cards are used. The teacher is more limited in the questions that can be asked when pre-printed response cards are used.

Lenox (1982) used pre-printed and write-on response cards to teach eight educable mentally retarded high school students how to complete job applications. The response cards were individual index cards (3" x 5") with phrases commonly used on job applications and the students' personal information printed on them. Write-on response cards were laminated index cards with lines. Students used water soluble pens to write on the index cards.

Hoagland (1983) used response cards to instruct six learning disabled high school students in traffic laws and signs. Each student had a card (3" x 3") printed with "yes", "no", "true", "false", "a-e", and traffic signs. While both of these studies incorporated response cards as an important component of the instructional procedures, they did not compare the effects of response cards with other forms of student responding.
Wheatley (1986) compared the effectiveness of hand raising and response cards in teaching money skills to nine developmentally handicapped students. Hand raising was when students raised a hand above their head in response to a teacher question and waited to be called on by the teacher. Response cards were pre-printed with the numbers 0-9 or the words true and false which the students showed in response to questions about money. An alternating treatments design within a multiple baseline across behaviors was used to compare the two forms of responding. Results showed that each student's mean rate of response during hand raising sessions was .51 responses per minute and .98 responses per minute during response card sessions. The students averaged 1.5 items correct on the 5 point daily quizzes after each hand raising session, while correctly answering an average of 4.0 items following response card sessions.

Narayan (1988) compared the effectiveness of response cards and hand raising with whole class social studies instruction. The subjects were 20 students enrolled in a fourth grade classroom in
an inner city public school. Six target students were selected by the students' regular teacher two each representing high, middle, and low functioning students. These target students were observed for rate and accuracy of responding during instruction. A 10-point quiz was administered after each session as a measure of student learning.

Results indicated that response cards increased active student responding as compared with hand raising, while teacher presentation time and review time remained consistent. During the two hand raising phases the six target students responded at an average rate of .10 per minute. During write-on response card sessions, the same students responded at an average response rate of 96 per minute for. Overall, 13 of the 20 students earned better quiz scores following instruction using response cards, than they earned when the hand raising procedure was employed during instruction. The quiz scores for 10 of the 15 students for which there was sufficient data to make a comparison) of the students were increased during the response card sessions, while there was
no discernable change for 5 students. However, no student did scored higher during the hand raising phases than during the response card phases. As a class, the average median quiz score during the two hand raising phases was 7.6 and 6.7, compared to 8.6 and 8.0 during the response card phases.

In a second experiment Narayan (1988) compared pre-printed response cards with hand raising during four sessions in which the social studies content presented in Experiment I was reviewed. An alternating treatments design was used to analyze the two types of student responding. Narayan presented facts/concepts on an overhead projector of about 7 minutes then for 10 minutes asked rapid paced questions with students responding using either hand raising or pre-printed response cards. After the 10 minutes had ended the teacher presented additional facts/concepts then reviewed this information using the mode of student responding not used during the previous 10 minutes. Results indicated that pre-printed response cards were superior to hand raising in terms of teacher presentation rate, total response
rate, correct response rate, and performance of the review quiz.

This second experiment was done for only a brief time (four days) and a more complete analysis of the two forms of student responding needs to be done. The rate of student responding was 4.38 responses per minute using pre-printed response cards to 2.5 response attempts during hand raising and an average rate of only .16 actual responses per minute in the hand raising condition.

This dissertation represents a systematic replication of Narayan's study. The study was conducted with a different student population (5th grade regular classroom) in a different school in a large urban school district, and science instead of social studies was used as the instructional contents. The study tried to control for certain problems reported in the Narayan research. A 16-item daily quiz was used in an effort to control for a possible ceiling effect. Students were not quizzed on the instructed material at the end of each session, instead the quiz was given occur just prior to the next instructional session. Also, unit tests were be given every 2 weeks to assess the students' retention of instructed information.
CHAPTER III

METHOD

This chapter describes the methods used to conduct the study. It is divided into the following sections: subjects and setting, experimenter and observers, definition and measurement of dependent variables, reliability of data, subject matter and curriculum design, materials, experimental design, and procedure.

Subjects and Setting

The subjects were students in a regular fifth grade classroom in an urban elementary school (see Figure 1). There were 25 students in the class, 14 boys and 11 girls. Twelve students were black and 13 students were white. Students' parents were notified about the project by letter. The experimenter sent a cover letter to parents explaining the project along with a permission form for the students to participate in the research. Appendix A included a sample of the permission form sent to parents/guardians to obtain permission for their children to participate in the project. In cases
Figure 1. Classroom Setting and Seating Chart of Subjects.
where there was no response to the letter from the parents the experimenter telephoned the parents individually and subsequently sent another permission slip home to the parent by the student. The experimenter was able to obtain permission slips for all the students using these strategies.

All students in the class were involved in the daily instruction, daily quizzes, and unit tests. For the purposes of this study, the students were identified as either at risk or non at risk. At risk students were those who were doing poorly academically based on their report card and their teacher's evaluation. At risk students were those students who were receiving a failing grade "F", and/or barely passing grade "D", in at least three of their four main subjects as decided on by the experimenter and classroom teacher were: reading, math, science, language arts. At risk students also included students who were in danger of failing academically based on the three previous grading periods, and/or were being considered for a special education placement. Table 1 shows the status, age, and standardized test score for each subject.
**Table 1**

**Student Information.** Table 1 indicates whether the student was considered at risk or not at risk, the age of each student in years and months, and the total reading and math score for each student on the Comprehensive Tests Basic Skills (CTBS). The CTBS was administered to the students in April 1989.

<table>
<thead>
<tr>
<th>STUDENT</th>
<th>STATUS</th>
<th>AGE</th>
<th>READING&lt;sup&gt;a&lt;/sup&gt;</th>
<th>MATH&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Not At Risk</td>
<td>11 - 05</td>
<td>31</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>Not At Risk</td>
<td>11 - 05</td>
<td>69</td>
<td>74</td>
</tr>
<tr>
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<td>At Risk</td>
<td>12 - 02</td>
<td>10</td>
<td>4</td>
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<td>10 - 08</td>
<td>11</td>
<td>10</td>
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</tbody>
</table>

**Notes**

- <sup>a</sup> Reading percentile scores on the CTBS
- <sup>b</sup> Math percentile scores on the CTBS
- <sup>c</sup> Minimum score noted for CTBS
- <sup>d</sup> No data
Six target students (Students 1, 2, 4, 5, 7, and another student who had insufficient data to remain part of the study) were initially selected for observation during instruction. Three of the target students were academically at risk, and three were non at risk. Two additional at risk students (Students 3 and 6) were chosen during the project to compensate for the attrition (repeated suspension, due to problems not related to this project) of Student 23 one of the target at risk students and the potential lose of Student 7.

The students' regular second floor classroom (see Figure 1) served as the site for this project. The school was located in a low socioeconomic area of a large midwestern city. Some of the students in the class were bussed in from another low socioeconomic area of the city. Ten students were determined at risk and 15 non at risk. One student was transferred to a classroom for student with severe behavior problems during the first week of this project. Additionally, during the course of the study one target at risk student and a non targeted at risk student was lost due to
school suspensions.

A first year doctoral student in applied behavior analysis served as the primary observer and data collector. The regular classroom teacher and a classroom aide served as the second observers for interobserver agreement purposes and as the primary observer when the other observer was unable to be present. The experimenter served as the teacher during this research project.

**Experimenter and Observers**

The experimenter was a second year doctoral candidate majoring in special education with an emphasis in applied behavior analysis at The Ohio State University. He had worked as a youth leader in the Ohio Youth Commission (OYC) for 2 years and as a social worker for OYC for 3 years. The experimenter has had experience as an educator for 3 years and as a teacher of severe behavior handicapped students for 6 years. During the study the experimenter served as the teacher during all the sessions.
Three different observers collected data. The primary observer was a first year doctoral student with a major in special education and applied behavior analysis at The Ohio State University. The primary observer was present for 20 of the 26 sessions. The regular classroom teacher also served as a secondary (reliability) observer except during the sessions when the primary observer was not present at which times she became the primary observer. The teacher had 16 years experience teaching in elementary schools. The third observer was a freshmen undergraduate student who was doing his early classroom observation in this particular room.

**Definition and Measurement of Dependent Variables**

Seven dependent variables were measured during the study:

1. teacher presentation rate, 2. rate of student response during instruction, 3. accuracy of student response during instruction, 4. rate of student hand raising during instruction, 5. daily quiz scores, 6. unit review tests, and 7. students preferences and opinions of the different response modes used in the study.
Teacher Presentation Rate

Teacher presentation rate was defined as the rate per minute of learning trials presented by the teacher. A learning trial was defined as the teacher's presentation of a question or statement, the student(s) response to the question or statement, and the teacher's delivery of either praise for a correct response or corrective feedback for an incorrect response. For example, Teacher: "Name the male part of a plant."; Student(s): "Stamen."; Teacher: "That is correct!"

The total number of learning trials presented during an instructional session was obtained by counting the number of learning trials marked by the observer on the data sheet. Teacher presentation rate was calculated using the formula:

\[
\text{No. of learning trials} \quad \frac{\text{Total instruction time}}{\text{in minutes}} = \text{Teacher presentation rate}
\]
Rate of Student Response During Instruction.

When the hand raising condition was in effect, a student response was recorded whenever a student raised his/her hand in response to a question posed by the teacher, kept his/her hand raised until called upon by the teacher, and made a response in answer to the posed question.

When the write-on response cards were used, a student response was recorded whenever a student wrote on the response card his/her answer in response to the teacher's question and cue to "Write your answer", and then held the response card up over his/her head in response to the teacher's next cue of, "Hold up your card". Rate of student response during instruction was calculated using the formula:

\[
\text{Response per minute rate} = \frac{\text{Total number of response}}{\text{Total instruction time in mins}}
\]

The observers were trained to observe six target students and record data on rate and accuracy of student response. The target students were divided into two groups of three. Each group
of target students was observed on alternating learning trials. When two of the at risk target students began having periodic problems resulting in suspensions, two additional at risk students were selected for observation. The observers were retrained to accurately record the responses of eight students for those sessions when all target students were present.

Data collection sheets were used to record both student responses and non-responses. Appendix B shows an example of the data sheet. The total time for instruction and review were kept by the observers with a stopwatch. The teacher used verbal cues; "Let us begin" and "Let's stop now", to let the observer know when to start and stop the stopwatch.

Rate of Hand Raising

During sessions in which the hand raising condition was in effect, the observers recorded each time a target student raised his or her hand, whether or not the student was called upon by the teacher to give the answer. Recording of these attempts to respond
were unique to the hand raising condition. Rate of hand raising was calculated in the same manner of rate of student response.

**Accuracy of Student Response During Instruction.**

The observers recorded a student response during hand raising sessions as correct if the student's response matched one of the corresponding answers on a pre-prepared answer sheet. The answer sheet was prepared by the experimenter before each session and contained all acceptable answers to each question. Appendix C contains an answer sheet for Session 10 during which life processes in plants was presented.

A correct student response during response card sessions was recorded whenever the answer written on the student's response card matched the appropriate answer on the prepared answer sheet. Student responses were counted as correct even if any of the following spelling errors were made: reversal of two letters, addition of an extra letter, omission of a single letter, or substitution of a single letter, as long as the spelling error did not produce another incorrect response (e.g., *car* for *card*). Responses
were also counted as correct if the student spelled all or part of a word phonetically and the word contained the proper number of syllables. For example, both Sinsinatì and Cinicinatì would have been accepted as correct responses for Cinicinatì; but Cinatì or Sinnaty would have been scored as incorrect responses.

Accuracy of student response was reported as a percentage of all student responses that were correct, using the formula:

\[
\frac{\text{No. of correct responses}}{\text{Total no. of responses}} \times 100 = \% \text{ Accuracy}
\]

The total number of responses was the sum of both correct and incorrect answers given in response to questions posed by the teacher. Observers circled a "C" on the data sheet if the student's response was correct and an "I" if the response was incorrect. (See Appendix B)

Daily Quiz Scores

Daily quizzes consisted of 16 items. Items 1-8 were recall questions and items 9-16 were recognition items. An item on the daily quiz was marked correct if it matched the answer on the
prepared answer key. The same rules regarding spelling errors that were used to judge students’ written responses during instruction were applied to students’ responses on the quizzes. One point was given for each item answered correctly. A student’s daily quiz score was the total number of items marked correct on the quiz. A record was also kept of the number of each question type (recognition and recall) that each student answered correctly. An example of a daily quiz, can be found in Appendix D.

**Unit Tests**

A unit test was given at the end of approximately each 2-week period of instruction, during which there had been a minimum of 6 daily lessons. Each unit test covered material from all the lessons in the preceding 2-week period. Unit tests were administered using the same rules that were used for the daily quizzes and consisted of 40 items. Each unit test consisted of 20 recall and 20 recognition items presented in an alternating manner, with all odd number items being recognition questions and even number items being recall questions. An example of a unit test can
be found in Appendix E.

**Student Preferences and Opinions**

Students' preferences and opinions regarding hand raising and response cards were obtained through an interview following the last phase of the study (see Appendix F). This interview was conducted by the experimenter, who met individually with the each student for approximately 10 minutes.

**Reliability of Data**

**Instructional Variables**

An independent observer was trained and instructed to use the same data sheet used by the primary observer (see Appendix B) to collect data on teacher presentation rate, rate of student response, and accuracy of student response. Interobserver agreement scores were obtained on at least two sessions per phase and for 50% of all sessions.

The primary observer sat facing the students at a small table to right of the experimenter. The other observers sat at a large
table to the left of the experimenter, along the same wall as the primary observer. The primary observer at the small table sat on the right end of the table just left of the classroom door. The observer at the large table sat at the left end of the table just right of the classroom teacher’s desk. The teacher stood in front the students and just to the left of the overhead project, also to the front and left of the projector screen. Each observer had his/her own data recording sheet, a copy of all the correct responses to the teacher’s questions, and a pencil. The primary observer also had a stopwatch.

The primary observer used a hand signal easily seen by the secondary observer to ensure that the two observers were observing the same group of target students on any given learning trial. The formula used to establish the percentage of agreement among observers was the number of agreements divided by the total agreements plus disagreements multiplied by 100.

\[
\text{Agreements} \div \text{Agreements + Disagreements} \times 100 = \% \text{ of Agreement}
\]
Quiz and Test Scores

Accuracy of the scoring of the daily quizzes and unit tests was checked by having a second observer independently score unmarked photocopies of the quizzes and tests for at least 25% of all sessions. An item was scored as correct if the answer was the same as the answer on the quiz or test answer key. The second observer was asked to place a check( ) to the left of all correct answers and circle all incorrect answers. Additionally, the observer was asked to write total number of correct items and the number of correct recall and recognition items on the top of each quiz.

Subject Matter and Curriculum Design

Science was the subject matter for all instructional sessions. The information was designed to be used for daily whole-class instruction and it called for short one word answers from the students. Specific science units were developed on weather, air, air temperature, air moisture, climates, weather forecasts, storms, atmosphere, plants, life processes in seed plants, and the solar system. Curriculum resources of science included the 5th grade

Materials

Lecture Outlines

A lecture outline was prepared by the experimenter for each session. Each lecture outline contained all of the science facts/concepts to be presented during the session. The teacher used the lecture outline to generate questions during both instruction and review. A sample lecture outline can be found in Appendix G.

Instructional Transparencies

Transparencies were used by the teacher to present information to the students. (See Appendix H).

Overhead Projector

An overhead projector was used to project instructional transparencies onto a screen.
Movie Screen

A portable "60 x "60 movie screen was used to show the transparencies to the students.

Write-on Response Cards

Write-on response cards were 12" x 9" particle boards covered on one side with white laminate. Students wrote responses on the response cards with a dry erase marker in response to questions posed by the teacher during instruction.

Dry Erase Markers

Each student was supplied with a dry erase marker ("Expo" brand) on response card days with which to write their responses on the write-on response cards.

Facial dry tissues

Tissues were used by the students to erase their responses on their individual response cards.

Water soluble marking pens

Various colored fine point water soluble overhead projector pens ("VisaVis" brand) were used by the teacher to write on the
instructional transparencies.

**Daily Quizzes**

A daily quiz was given at the beginning of each session. There was a minimum of 24 hours between instruction on information and the quiz on that information. Each quiz consisted of 16 questions, 8 were recognition items (multiple choice/true or false) and 8 recall items (short answers/fill in the blanks).

**Daily Quiz Answer Form**

Students responded to the questions on the daily quiz by writing their answers on the answer form. A sample answer form can be found in Appendix I.

**Unit Tests**

A unit test was given every 2 weeks and covered information presented during that period. Each unit test consisted of 40 questions, 20 recognition items (multiple choice or true and false) and 20 recall items (short answer/fill in the blank).
Unit Test Answer Form

Students responded to the questions on the unit test by writing their responses on the answer form. A sample form can be found in Appendix J.

Cover Sheet for Quizzes and Unit Tests

A yellow sheet of 8 1/2" x 11" paper served as the cover sheet. The paper was distributed to the students prior to each quiz and unit test to be used in covering their answers during the tests and quizzes.

Data Collection Sheets

Data collection sheets were used to record the number of responses and number of correct responses made by each of the eight target students. Total instruction time was also marked on these sheets. A sample data collection sheet can be found in Appendix B.

Stop watch

The teacher used a stop watch to record total instructional time.
Experimental Design

An ABAB reversal design was used in this study (Baer, Wolf, & Risley, 1968; Cooper, Heron, & Heward, 1987). The baseline (A) phases consisted of hand raising and the independent variable, write-on response cards, was present during the B phases. The reversal design was chosen in order to look for a functional relationship between the mode of student response and rate and accuracy of student response and performance on daily quizzes.

The initial phase of the study consisted of nine sessions of the hand raising conditions. The second phase consisted of nine response card condition sessions. The third phase consisted of four sessions under the hand raising condition. The fourth and final phase consisted of four response card sessions.

Procedure

General Procedures.

The teacher prepared for each session by setting up the overhead projector and screen, and arranging the quiz or unit test transparencies, and the lecture outline and instructional
transparencies. Before each write-on response card session, a dry erase marker and facial tissue was placed on each student's desk.

Each instructional session lasted approximately 45-55 minutes and consisted of three parts. The first part of each session entailed returning the most recently completed quiz and the administering of the daily quiz covering the previous session's instruction. Each student was given an answer sheet marked from 1-16, on which they would write their responses. Students also received a yellow cover sheet to use in concealing their answers from others during the exams. Students wrote their responses to recall questions in one or two words and for the recognition questions the students would write either the letter preceding their choice (i.e. a, b, c, or d) or "True" or "False". The students were told that their quiz scores would count toward their science grade and to do their best on the quizzes. Students were encouraged to improve their scores from one session to the next and told not to worry about comparing scores with others in the class. Students were instructed to do their best with spelling and to spell words by
"sounding them out according to the number of syllables". Students who were present for a lesson but absent for the quiz on that lesson were given the missed quiz if they were present at the next session. This make-up quiz was administered by the observer orally while the remained of the class took the quiz from the previous session. No other opportunities were provided for making-up the quiz. If a student missed a unit test the student made-up the unit test at the first available opportunity.

The teacher used progressive disclosure to project each quiz/unit test question with the overhead projector. To control for the wide range of reading skills in the class, each question was read aloud twice by the teacher. Before projecting the next question, the teacher waited for 10 seconds after reading each recall question for the second time and for 5 seconds after reading each recognition question the second time. After all 16 items had been presented, students were allowed to request that specific questions be reread.
During the second part of each session the teacher presented science information to the students and questioned them after each fact/concept had been presented. The teacher used verbal communication, overhead projector materials, and science demonstrations to instruct the students. The teacher had the facts and concepts to be covered for each lesson printed by hand on overhead projector transparencies. Using progressive disclosure and corresponding verbal communication, the teacher presented each fact/concept to be covered during the lesson. After each item was presented both on the overhead projector and verbally, the teacher covered up the information on the overhead projector and asked a question about the fact/concept just presented. During hand raising sessions, if the student called upon responded correctly, the teacher said the student's name followed by a positive comment (e.g., "Yes, Jim, that is correct. Excellent!") If the student who was called upon answered incorrectly the teacher said, "No, the answer is".
During response card sessions, if most or all of the students held up the correct answer, the teacher said "Great class! That is correct!". If some students had written the correct response but many students displayed an incorrect response, the teacher responded by saying "I see some of you have the correct answer of _______." If most of the class displayed an incorrect answer, the teacher said "Class the correct answer is _______."

The third and final part of each instructional session consisted of a review all the facts/concepts presented during the session. The teacher asked a series of questions using the lecture outline. The teacher provided feedback for student responses in the same manner as before. The review consisted solely of teacher posed questions about the material presented, student responses to the questions, and the teacher's feedback for student responses to each question. The presentation and review of facts/concepts lasted approximately 25 minutes.

When unplanned interruptions (e.g., announcements on the intercom, fire drill) occurred during a session, the teacher cued the
observer(s) to stop the stopwatch and cease collecting data by saying, "Let's stop for a moment". After the interruption had ended, the teacher cued the observer(s) to start data collection saying, "Let's go back to our lesson now".

Hand Raising

Prior to the first experimental session, the teacher conducted a hand raising training session for about 20 minutes using a geography lesson on South America. The teacher trained the students on the correct procedures for responding to the teacher's questions. Students were instructed to raise one hand at least head high if they wished to respond to a question. A hand raise was not recorded if a student raised his or her hand lower than head high, had the palm of their raised hand touching their head or face, or if their head was laying on their desk. Students were required to keep their hand raised until the teacher had called upon a student to respond to the question.

Students were instructed to raise their hands after the teacher posed a question if they wished to answer the question and
wait until they are called upon to answer. When the teacher called one student's name, all other students who had their hands raised were to lower their hands while the called upon student gave his/her answer in one or two words.

The primary and reliability observers also participated in this hand raising training session in order to practice the observation and recording procedures.

On the first day of baseline, the teacher introduced the students to the content to be covered and reviewed the hand raising procedures with the students. The teacher modeled examples and non-examples of hand raising, the students used "Yes/No" choral responding to indicate whether the example is appropriate or not.

During the instructional sessions the teacher waited for 3 seconds after asking each question and then called upon one student to answer the question. The teacher would count to 3 seconds by covertly saying "One thousand one, one thousand two, one thousand three".
The teacher used a list of all of the students' names to determine who would be called upon to answer each question. A list of random numbers was used to create five different lists of the students' names to be used on alternating days. This was done to eliminate the possibility of teacher bias in calling on certain students more than others. The random lists were made by assigning a number to each student's name then placing one corresponding number for each student on a separate sheet of paper. The slips of paper were then placed in a bag and drawn out one at a time. Each number that was drawn out was matched with the name it represents to determine the order of the names on the list until all the numbers had been drawn. This procedure was repeated five times in order to produce the five random lists used during the study.

The teacher called on the first student on the list to answer the first question, the second person to answer the second question, and so on. The student to be called upon did not have his/her hand raised, the teacher would proceed down the list, and calling on the
next student on the list who had his/her hand raised. The teacher looked at the random list for the name of the student while counting the 3 seconds wait time. If the teacher passed a name and the student had not raised his/her hand at that point, but subsequently raised his/her hand prior to the teacher identifying another student, the teacher would back up on the list and call upon the student.

**Write-on Response Cards**

The teacher held a write-on response card practice session the day prior to the first session of the first response card phase. A geography lesson on Africa was used for this training lesson that took about 10 minutes. Students were instructed to respond to the teacher’s questions by printing one-or-two word answers on their individual write-on response cards. The primary and reliability observers also participated in this session in order to practice the observation and recording procedures.

After posing each question the teacher said "Write" to cue the students to begin writing their answer. After a 5-second wait time
(determined by the teacher counting to himself), the teacher said "Hold up your cards". The students then held their response cards above their heads so that the teacher could see all the students' responses. The teacher then said, "Put down your cards and erase your answers.". The students would erase their answers and get ready for the next question.

The students were told that if they did not play with the markers and response cards during the instruction, at the end of the lesson they would be given 3 minutes of free time to draw on the response cards.
CHAPTER IV

RESULTS

This chapter presents the results of the study comparing the effectiveness of hand raising and write-on response cards. Data on the rate of learning trials presented by the teacher are followed by the results for the seven target students on student responding during instruction (response attempts, response rate, and response accuracy). Results of daily quizzes performance by all the students are then presented. The results on the bi-weekly unit tests are then presented for each student. A summary of the students' opinions about the two student response modes used in the study is presented. The chapter concludes with a description of interobserver agreement results.

Teacher Presentation Rate

Figure 2 shows the rate per minute of teacher presented learning trials during hand raising and response card conditions.

85
Figure 2. Rate of teacher presented learning trials per minute during hand raising (HR) and response card (RC) conditions.
Hand Raising.

During the first hand raising phase of the study the teacher presented learning trials at a mean rate of 1.46 trials per minute with a range of 1.0-2.06 trials per minute.

During the second hand raising phase the teacher presented learning trials at a mean rate 1.72 trials per minute with a range of 1.2-2.16 learning trials per minute.

The mean teacher presentation rate for both hand raising phases was 1.54 learning trials per minute (See Table 2).

Response card.

During the first response card phase the teacher presented learning trials at a mean rate of .98 per minute with a range of .8-1.24 learning trials per minute.

During the second response card phase the teacher presented learning trials at a mean rate of .1.02 per minute with a range of .95-1.17 trials per minute (See Table 2).

The mean teacher rate for presentation of learning trials in both response cards phases was .99 trials per minute (see Table 2).
Table 2

Mean and Range of Teacher Presentation Rate per Minute by Experimental Condition and Combined Teacher Presentation Rate for Learning Trials During Hand Raising and Response Card Conditions.

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<thead>
<tr>
<th></th>
<th>HR 1</th>
<th>RC 1</th>
<th>HR 2</th>
<th>RC 2</th>
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<th>RC</th>
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<tr>
<td>Mean</td>
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<td>.98</td>
<td>1.72</td>
<td>1.02</td>
<td>1.54</td>
<td>.99</td>
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<td>Range</td>
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<td>.8-1.24</td>
<td>1.2-2.16</td>
<td>.95-1.17</td>
<td>1.0-2.16</td>
<td>.95-1.24</td>
</tr>
</tbody>
</table>
Student Responding During Instruction

Hand Raising Rate

The student hand raising rate and student response rate are compared during the two hand raising phases for each target student, on a session-by-session basis (see Figures 3-9). Data on Student 3 and Student 6 were collected only for sessions 13-26.

**Student 1.** Figure 3 provides a session by session comparison of responses and hand raising of Student 1. During the first hand raising phase Student 1's mean hand raising rate was .41 responses per minute with a range of 0.0-1.12 hand raising per minute.

During the second hand raising phase Student 1's mean rate of hand raising was 1.2 per minute with a range of .7-2.04 per minute. The mean hand raising rate for both hand raising phases was .67.

**Student 2.** Figure 4 provides a session by session comparison of responses and hand raising of Student 2. During the first hand raising phase Student 2's mean hand raising rate was .97 responses per minute with a range of 0.12-1.3 hand raising per minute.
Figure 3. Student 1's rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.

Figure 4. Student 2's rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.
During the second hand raising phase Student 2's mean rate of hand raising was 1.0 per minute with a range of .7-1.3 per minute. The mean hand raising rate for both hand raising phases was .98.

**Student 3.** Figure 5 provides a session by session comparison of responses and hand raising of Student 3. Data was not collected on Student 3's responding during the first hand raising phase.

During the second hand raising phase Student 3's mean rate of hand raising was .28 per minute with a range of 0.0-.4 per minute.

**Student 4.** Figure 6 provides a session by session comparison of responses and hand raising of Student 4. During the first hand raising phase Student 4's mean hand raising rate was .47 responses per minute with a range of 0.12-1.03 hand raising per minute.

During the second hand raising phase Student 4's mean rate of hand raising was .21 per minute with a range of 0.0-.6 per minute. The mean hand raising rate for both hand raising phases was .34.
Figure 5. Student 3’s rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.

Figure 6. Student 4’s rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.
Student 5. Figure 7 provides a session by session comparison of responses and hand raising of Student 5. During the first hand raising phase Student 5's mean hand raising rate was 0.0 responses per minute with a range of 0.0-0.0 hand raising per minute.

During the second hand raising phase Student 5's mean rate of hand raising was .27 per minute with a range of 0.0-.58 per minute. The mean hand raising rate for both hand raising phases was .14.

Student 6. Figure 8 provides a session by session comparison of responses and hand raising of Student 6. Data was not collected on Student 6's responding during the first hand raising phase.

During the second hand raising phase Student 6's mean rate of hand raising was .15 per minute with a range of 0.0-.4 per minute.

Student 7. Figure 9 provides a session by session comparison of responses and hand raising of Student 7. During the first hand raising phase Student 7's mean hand raising rate was .073 responses per minute with a range of 0-.28 hand raising per minute.
Figure 7. Student 5's rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.

Figure 8. Student 6's rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.
Figure 9. Student 7's rate of student responding during hand raising (HR) and response card (RC) conditions and the rate of hand raising during HR phases.
During the second hand raising phase Student 7's mean rate of hand raising was 0 per minute with a range of 0-0 per minute. The mean hand raising rate for both hand raising phases was 0.

**Response Rate**

Figures 10-16 show the comparison of the student rate of responding and the percent of accurate responses made across the hand raising and response card phases for the seven target students.

**Student 1.** Figure 10 shows a comparison of Student 1's responding and accuracy of responses across the experimental phases. During the first hand raising phase the Student 1's mean rate of response was .062 responses per minute with a range of 0-.18. During the second hand raising phase the Student 1's response rate was .23 responses per minute with a range of 0-.8 responses per minute. The mean response rate for both hand raising phases was .11 (see Table 3).

During the first response card phase Student 1's mean response rate was .9 responses per minute with a range of .53-1.1 response per minute. During the second response card phase
Table 3

Mean Student Response Rate and Mean Correct Rate per Minute During Hand Raising and Response Card Conditions.

<table>
<thead>
<tr>
<th>Student</th>
<th>HR 1</th>
<th>RC 1</th>
<th>HR 2</th>
<th>RC 2</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(NAR)</td>
<td>06a/06b</td>
<td>9/8</td>
<td>23/23</td>
<td>1.25/.98</td>
<td>.11/.11</td>
</tr>
<tr>
<td>2(NAR)</td>
<td>15/03</td>
<td>.97/.96</td>
<td>.03/.02</td>
<td>.98/.98</td>
<td>.1/.11</td>
</tr>
<tr>
<td>3(AR)</td>
<td>---</td>
<td>.66/.36</td>
<td>.06/.03</td>
<td>.63/.31</td>
<td>----</td>
</tr>
<tr>
<td>4(AR)</td>
<td>1/09</td>
<td>.70/.64</td>
<td>.08/.08</td>
<td>.96/.53</td>
<td>.09/.08</td>
</tr>
<tr>
<td>5(NAR)</td>
<td>0/0</td>
<td>.93/.89</td>
<td>.03/.06</td>
<td>.75/.71</td>
<td>.14/.03</td>
</tr>
<tr>
<td>6(AR)</td>
<td>----</td>
<td>.57/.53</td>
<td>.03/.02</td>
<td>.33/.26</td>
<td>----</td>
</tr>
<tr>
<td>7(AR)</td>
<td>0/0</td>
<td>.22/.20</td>
<td>0/0</td>
<td>.22/.18</td>
<td>.00/0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>06/.04</th>
<th>.71/.63</th>
<th>.58/.06</th>
<th>.73/.57</th>
<th>.09/.07</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>05/.05(2)</td>
<td>.53/.43</td>
<td>.04/.03</td>
<td>.53/.32</td>
<td>.05/.04(2)</td>
</tr>
</tbody>
</table>

NOTES
NAR = Not At Risk AR = At Risk
a = Student Response Rate per Minute
b = Correct Rate per Minute
-- = No Data
(2) = Only 2 students' data combined
Figure 10  The rate of Student 1's responding per minute and the percent correct during HR and RC conditions.
Student 1's mean response rate was 1.02 per minute with a range of .95-1.17 per minute. The mean response rate for both response card phases was .96 (see Table 3).

Student 2. Figure 11 shows a comparison of Student 2's responding and accuracy of responses across the experimental phases. During the first hand raising phase the Student 2's mean rate of response was .15 responses per minute with a range of 0-.28. During the second hand raising phase the Student 2's response rate was .025 responses per minute with a range of 0-.1 responses per minute. The mean response rate for both hand raising phases was .10 (see Table 3).

During the first response card phase Student 2's mean response rate was .97 responses per minute with a range of .79-1.24 responses per minute. During the second response card phase Student 2's mean response rate was .98 per minute with a range of .95-1.02 per minute. The mean response rate for both response card phases was .97 (see Table 3).

Student 3. Figure 12 shows a comparison of Student 2's responding and accuracy of responses across the experimental
Figure 11. The rate of Student 2's responding per minute and the percent correct during HR and RC conditions.

Figure 12. The rate of Student 3's responding per minute and the percent correct during HR and RC conditions.
phases. Data was not collected on Student 3's responding during the first hand raising phase. During the second hand raising phase the Student 3's response rate was .06 responses per minute with a range of 0-.23 responses per minute (see Table 3).

Data collection began for Student 3 during session 13 (the fourth response card session). During the first response card phase Student 3's mean response rate was .66 responses per minute with a range of .2-1.03 response per minute. During the second response card phase Student 3's mean response rate was .63 per minute with a range of .4-1.0 per minute. The mean response rate for both response card phases was .64 (see Table 3).

**Student 4.** Figure 13 shows a comparison of Student 4's responding and accuracy of responses across the experimental phases. During the first hand raising phase the Student 4's mean rate of response was .1 responses per minute with a range of 0-.22. During the second hand raising phase the Student 4's response rate was .08 responses per minute with a range of 0-.12 responses per minute. The mean response rate for both hand raising phases was .09 (see Table 3).
Figure 13. The rate of Student 4's responding per minute and the percent correct during HK and RC conditions.
During the first response card phase Student 4's mean response rate was .7 responses per minute with a range of .46-1.04 response per minute. During the second response card phase Student 4's mean response rate was .96 per minute with a range of 1.2-.73 per minute. The mean response rate for both response card phases was .71 (see Table 3).

Student 5. Figure 14 shows a comparison of Student 5's responding and accuracy of responses across the experimental phases. During the first hand raising phase the Student 5's mean rate of response was 0.0 responses per minute with a range of 0 -0.0. During the second hand raising phase the Student 5's response rate was .027 responses per minute with a range of 0-.58 responses per minute. The mean response rate for both hand raising phases was .02 (see Table 3).

During the first response card phase Student 5's mean response rate was .93 responses per minute with a range of .74 -1.15 response per minute. During the second response card phase Student 5's mean response rate was .75 per minute with a range of .4-.95 per minute. The mean response rate for both response card
Figure 14: The rate of Student 5’s responding per minute and the percent correct during HR and RC conditions.
phases was .84 (see Table 3).

**Student 6.** Figure 15 shows a comparison of Student 6's responding and accuracy of responses across the experimental phases. Data was not collected on Student 6's responding during the first hand raising phase. During the second hand raising phase the Student 6's response rate was .03 responses per minute with a range of 0-.1 responses per minute (see Table 3).

Data collection began for Student 6 during session 13 (the fourth response card session). During the first response card phase Student 3's mean response rate was .57 responses per minute with a range of .26-.87 response per minute. During the second response card phase Student 6's mean response rate was .33 per minute with a range of 0.0-.55 per minute. The mean response rate for both response card phases was .6 (see Table 3).

**Student 7.** Figure 16 shows a comparison of Student 7's responding and accuracy of responses across the experimental phases. During the first hand raising phase the Student 7's mean rate of response was 0.0 responses per minute with a range of 0-.0. During the second hand raising phase the Student 7's
Figure 15. The rate of Student 6's responding per minute and the percent correct during HR and RC conditions.

Figure 16. The rate of Student 7's responding per minute and the percent correct during HR and RC conditions.
response rate was 0.0 responses per minute with a range of 0-0 responses per minute. The mean response rate for both hand raising phases was 0.0 (see Table 3).

During the first response card phase Student 7’s mean response rate was 0 responses per minute with a range of 0-0 response per minute. During the second response card phase Student 7’s mean response rate was 0 per minute with a range of 0-0 per minute. The mean response rate for both response card phases was .22 (see Table 3).

**Student Accuracy Rate**

Figures 10-16 show the seven target students rate of responding per minute and percent of accuracy during the hand raising and response card phases for each session.

**Student 1.** Figure 10 provides a session by session comparison rate of responses per minute and percentage of accuracy of responses by Student 1. During the first hand raising phase Student 1’s mean correct response rate was .06 responses per minute with a range of 0.0-.18 correct responses per minute (see Table 3). Student 1’s percentage of accuracy was 100% for all responses (see Table 4).
Table 4

The Mean Percentage of Correct Student Responding by Experimental Condition for Each Student and the Group Mean for Each Experimental Condition.

<table>
<thead>
<tr>
<th>Students</th>
<th>HR 1</th>
<th>RC 1</th>
<th>HR 2</th>
<th>RC 2</th>
<th>Combined HR</th>
<th>Combined RC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.00</td>
<td>89.00</td>
<td>87.50</td>
<td>94.00</td>
<td>93.70</td>
<td>90.00</td>
</tr>
<tr>
<td>2</td>
<td>93.70</td>
<td>99.00</td>
<td>100.00</td>
<td>97.50</td>
<td>96.80</td>
<td>98.60</td>
</tr>
<tr>
<td>3</td>
<td>--</td>
<td>82.80</td>
<td>50.00</td>
<td>91.60</td>
<td>--</td>
<td>86.30</td>
</tr>
<tr>
<td>4</td>
<td>88.00</td>
<td>92.90</td>
<td>100.00</td>
<td>95.80</td>
<td>94.00</td>
<td>93.40</td>
</tr>
<tr>
<td>5</td>
<td>--</td>
<td>94.40</td>
<td>100.00</td>
<td>95.60</td>
<td>--</td>
<td>95.00</td>
</tr>
<tr>
<td>6</td>
<td>--</td>
<td>94.10</td>
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<td>60.10</td>
<td>--</td>
<td>79.00</td>
</tr>
<tr>
<td>7</td>
<td>--</td>
<td>78.90</td>
<td>--</td>
<td>75.00</td>
<td>--</td>
<td>77.30</td>
</tr>
</tbody>
</table>

| GROUP    | 93.90 | 90.00 | 89.60 | 87.00 | 94.80       | 88.50       |

No data --
During the second hand raising phase Student 1's mean rate of correct response rate was .23 per minute with a range of 0.0-.8 per minute. The mean correct response rate for the combined hand raising phases was .10 (see Table 3). Student 1's percentage of accuracy was 87.5% for all response attempts. Student 1's percentage of accuracy for the combined hand raising phases was 93.7% (see Table 4).

During the first response card phase Student 1's mean correct response rate was .8 responses per minute with a range of .53-1.09 correct responses per minute (see Table 3). Student 1's percentage of accuracy was 89% for all responses (see Table 4). During the second response card phase Student 1's mean rate of correct response rate was .98 per minute with a range of .94-1.02 per minute. The mean correct response rate for the combined response card phases was .89 (see Table 3). Student 1's percentage of accuracy was 94.0% for total responses. Student 1's percentage of accurate responses for the combined response card phases was 90% (see Table 4).
Student 2. Figure 11 provides a session by session comparison rate of responses per minute and percentage of accuracy of responses by Student 2. During the first hand raising phase Student 2's mean correct response rate was .15 responses per minute with a range of 0.0-.25 correct responses per minute (see Table 3). Student 2's percentage of accuracy was 93% for all responses (see Table 4).

During the second hand raising phase Student 2's mean rate of correct response rate was .025 per minute with a range of 0.0-.1 per minute. The mean correct response rate for both hand raising phases was .11 (see Table 3). Student 2's percentage of accuracy was 100% for all responses. Student 2's percentage of accuracy for the combined hand raising phases was 96.8% (see Table 4).

During the first response card phase Student 2's mean correct response rate was .96 responses per minute with a range of .79 -1.24 correct responses per minute (see Table 3). Student 2's percentage of accuracy was 99% for all responses (see Table 4). During the second response card phase Student 2's mean rate of correct response rate was .98 per minute with a range of .94-1.02
per minute. The mean correct response rate for the combined response card phases was .89 (see Table 3). Student 2's percentage of accuracy was 97.5% for all responses. Student 2's percentage of accurate responses for the combined response card phases was 98.6% (see Table 4).

**Student 3.** Figure 12 shows a session by session comparison of rate of responses per minute and percentage of accuracy of responses by Student 3. Data were not collected on Student 3 during the first hand raising phase (see Table 4).

During the second hand raising phase Student 3's mean rate of correct response rate was .027 per minute with a range of 0.0-.11 per minute (see Table 3). Student 3's percentage of accuracy was 50% for all responses (see Table 4).

Session 13 (the fourth response card session) was the first session during which data was collected on Student 3. During the first response card phase Student 3's mean correct response rate was .36 responses per minute with a range of .08-.85 correct responses per minute (see Table 3). Student 3's percentage of accuracy was 82.8% for all responses (see Table 4).
During the second response card phase Student 3's mean rate of correct response rate was .31 per minute with a range of .21-.42 per minute. The mean correct response rate for both response card phases was .33 (see Table 3). Student 3's percentage of accuracy was 91.6% for total responses. Student 3's percentage of accurate responses for the combined response card phases was 86.3% (see Table 4).

**Student 4.** Figure 13 shows a session by session comparison of rate of responses per minute and percentage of accuracy of responses by Student 4. During the first hand raising phase Student 4's mean correct response rate was .09 responses per minute with a range of 0.0-.19 correct responses per minute (see Table 3). Student 4's percentage of accuracy was 88% for all responses (see Table 4).

During the second hand raising phase Student 4's mean rate of correct response rate was .08 per minute with a range of 0.0-.11 per minute. The mean correct response rate for the combined hand raising phases was .08 (see Table 3). Student 4's percentage of accuracy was 100% for all responses. Student 4's percentage of
accuracy for the combined hand raising phases was 94% (see Table 4).

During the first response card phase Student 4's mean correct response rate was .65 responses per minute with a range of .38 - 1.07 correct responses per minute (see Table 3). Student 4's percentage of accuracy was 92.9% for all responses (see Table 4).

During the second response card phase Student 4's mean rate of correct response rate was .53 per minute with a range of .29 - .78 per minute. The mean correct response rate for the combined response card phases was .59 (see Table 3). Student 2's percentage of accuracy was 95.8% for all responses. Student 2's percentage of accurate responses for the combined response card phases was 93.4% (see Table 4).

Student 5. Figure 14 shows a session by session comparison of rate of responses per minute and percentage of accuracy of responses by Student 5. During the first hand raising phase Student 5's mean correct response rate was 0.0 responses per minute with a range of 0.0 - 0.0 correct responses per minute (see Table 3). Student 5 did not a accuracy percentage because there
were no responses (see Table 4).

During the second hand raising phase Student 5's mean rate of correct response rate was .06 per minute with a range of 0.0-.1 per minute. The mean correct response rate for both hand raising phases was .03 (see Table 3). Student 5's percentage of accuracy was 100% for all responses (see Table 4).

During the first response card phase Student 5's mean correct response rate was .89 responses per minute with a range of .26 -1.07 correct responses per minute (see Table 3). Student 5's percentage of accuracy was 94.4% for all responses (see Table 4).

During the second response card phase Student 5's mean rate of correct response rate was .71 per minute with a range of .4-.85 per minute. The mean correct response rate for both response card phases was .8 (see Table 3). Student 5's percentage of accuracy was 95.6% for all responses. Student 5's percentage of accurate responses for the combined response card phases was 95% (see Table 4).
Student 6. Figure 15 shows a session by session comparison of rate of responses per minute and percentage of accuracy of responses by Student 6. Data were not collected on Student 6 during the first hand raising phase (see Figure 4).

During the second hand raising phase Student 6's mean rate of correct response rate was .025 per minute with a range of 0.0-.1 per minute (see Table 3). Student 6's percentage of accuracy was 100% for all responses (see Table 4).

Session 13 (the fourth response card session) was the first session during which data were collected on Student 6. During the first response card phase Student 6's mean correct response rate was .54 responses per minute with a range of .26-.87 correct responses per minute (see Table 3). Student 6's percentage of accuracy was 94.1% for all responses (see Table 4).

During the second response card phase Student 6's mean rate of correct response rate was .27 per minute with a range of 0.0-.47 per minute. The mean correct response rate for the combined response card phases was .4 (see Table 3). Student 6's percentage of accuracy was 60.1% for all responses. Student 6's percentage of
accurate responses for the combined response card phases was 79% (see Table 4).

**Student 7.** Figure 16 shows a session by session comparison of rate of responses per minute and percentage of accuracy of responses by Student 7. During the first hand raising phase Student 7's mean correct response rate was 0.0 responses per minute with a range of 0.0-0.0 correct responses per minute (see Table 3). No percentage of accurate responses was obtained due to no responses during the phase (see Table 4).

During the second hand raising phase Student 7's mean rate of correct response rate was 0.0 per minute with a range of 0.0-.0.0 per minute. The mean correct response rate for both hand raising phases was 0.0 (see Table 3). No percentage of accurate responses was obtained due to no responses during the phase (see Table 4).

During the first response card phase Student 7's mean correct response rate was .20 responses per minute with a range of .0-.6 correct responses per minute (see Table 3). Student 7's percentage of accuracy was 78.5% for all responses (see Table 4).
During the second response card phase Student 7's mean rate of correct response rate was .18 per minute with a range of .0-.42 per minute. The mean correct response rate for the combined response card phases was .19 (see Table 3). Student 7's percentage of accuracy was 75% for all responses with a range of 0%-100%. Student 7's percentage of accurate responses for the combined response card phases was 77.3% (see Table 4).

**Group Results**

**Student Response Rate**

Table 3 shows the group mean response rate for the two hand raising phases separately and the combined mean response rate for the two hand raising phases.

The mean hand raising response rate for the group during the first hand raising phase was .06 student responses per minute with a range of 0.0-.15 student responses per minute. During the second hand raising phase the mean response rate was .07 with a range of 0.0-.23 student responses per minute. The mean student response rate for both hand raising phases was .09 responses per minute (see Table 3). The hand raising rate for both hand raising phases
was .49.

**Group Accuracy Response Rate**

Table 3 shows the group mean and range of the mean correct response rate for the two response card phases separately and the combined mean response rate for the two response card phases.

The mean hand raising response rate for the group during the first response card phase was .63 student correct responses per minute with a range of 0.0-1.15 student correct responses per minute. During the second response card phase the mean correct response rate was .98 with a range of 0.0-1.02 student correct responses per minute. The mean student correct response rate for both response card phases was .89 correct responses per minute (see Table 3).

The group response rate for the first response card phase was .71 responses per minute with a range of .22-.97. The group response rate for the second response card phase was .73 with a range of .22-1.25 responses per minute. The response rate for both response card phases was .72 responses per minute.
The group correct percentage for the first hand raising phase was 7.4% and 10.3% for the second hand raising phase. The correct percentage for both hand raising phases was 8.3%.

The group correct percentage for the first response card phase was 90% and 87.1 for the second response card phase. The correct percentage for both hand raising phases was 88.6% (see Table 4).

**Daily Quiz Scores**

**Hand raising and Response Card**

**Student 1**

Figure 17 shows Student 1's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 1's mean quiz score during the first hand raising phase was 12.7 items correct with a range of 10-15 items correct over 9 daily quizzes. During the second hand raising phase Student 1's mean quiz score was 12.0 items correct with a range of 10-15 items correct over 3 daily quizzes.

**Response Card.** Student 1's mean quiz score during the first response card phase was 14.5 items correct with a range of 12-16
Figure 17. Number of items answered correctly by Student 1 on daily quizzes during hand raising (HR) and response card (RC) conditions.
items correct over 9 daily quizzes. During the second response card phase Student 1's mean quiz score was 13.5 items correct with a range of 11-15 items correct over 4 daily quizzes.

**Student 2**

Figure 18 shows Student 2's performance on the daily 16-item quizzes across sessions by experimental phase.

*Hand Raising.* Student 2's mean quiz score during the first hand raising phase was 11.6 items correct with a range of 9-16 items correct over 8 daily quizzes. During the second hand raising phase Student 2's mean quiz score was 11 items correct with a range of 6-15 items correct over 4 daily quizzes.

*Response Card.* Student 2's mean quiz score during the first response card phase was 15.1 items correct with a range of 14-16 items correct over 9 daily quizzes. During the second response card phase Student 2's mean quiz score was 13.75 items correct with a range of 11-16 items correct over 4 daily quizzes.

**Student 3**

Figure 19 shows Student 3's performance on the daily 16-item quizzes across sessions by experimental phase.
Figure 18. Number of items answered correctly by Student 2 on daily quizzes during hand raising (HR) and response card (RC) conditions.

Figure 19. Number of items answered correctly by Student 3 on daily quizzes during hand raising (HR) and response card (RC) conditions.
**Hand Raising.** Student 3's mean quiz score during the first hand raising phase was 6.25 items correct with a range of 0-11 items correct over 8 daily quizzes. During the second hand raising phase Student 3's mean quiz score was 4.75 items correct with a range of 3-7 items correct over 4 daily quizzes.

**Response Card.** Student 3's mean quiz score during the first response card phase was 6.85 items correct with a range of 2-12 items correct over 8 daily quizzes. During the second response card phase Student 3's mean quiz score was 10.5 items correct with a range of 10-11 items correct over 2 daily quizzes.

**Student 4**

Figure 20 shows Student 4's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 4's mean quiz score during the first hand raising phase was 4 items correct with a range of 2-8 items correct over 9 daily quizzes. During the second hand raising phase Student 4's mean quiz score was 3.6 items correct with a range of 0-8 items correct over 3 daily quizzes.
Figure 20. Number of items answered correctly by Student 4 on daily quizzes during hand raising (HR) and response card (RC) conditions.
**Response Card.** Student 4's mean quiz score during the first response card phase was 6.5 items correct with a range of 4-10 items correct over 8 daily quizzes. During the second response card phase Student 4's quiz score was 6 items correct for one daily quiz.

**Student 5**

Figure 21 shows Student 5's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 5's mean quiz score during the first hand raising phase was 12.7 items correct with a range of 10-15 items correct over 9 daily quizzes. During the second hand raising phase Student 5's mean quiz score was 12.25 items correct with a range of 11-14 items correct over 4 daily quizzes.

**Response Card.** Student 5's mean quiz score during the first response card phase was 14.5 items correct with a range of 13-16 items correct over 9 daily quizzes. During the second response card phase Student 5's mean quiz score was 13.75 items correct with a range of 12-16 items correct over 4 daily quizzes.
Figure 21. Number of items answered correctly by Student 5 on daily quizzes during hand raising (HR) and response card (RC) conditions.
**Student 6**

Figure 22 shows Student 6's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 6's mean quiz score during the first hand raising phase was 6.4 items correct with a range of 2-8 items correct over 5 daily quizzes. During the second hand raising phase Student 6's mean quiz score was 4.75 items correct with a range of 0-12 items correct over 4 daily quizzes.

**Response Card.** Student 6's mean quiz score during the first response card phase was 7.7 items correct with a range of 5-11 items correct over 7 daily quizzes. During the second response card phase Student 6's mean quiz score was 8 items correct with a range of 5-11 items correct over 2 daily quizzes.

**Student 7**

Figure 23 shows Student 7's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 7's mean quiz score during the first hand raising phase was 3.2 items correct with a range of 0-8 items
Figure 22. Number of items answered correctly by Student 6 on daily quizzes during hand raising (HR) and response card (RC) conditions.

Figure 23. Number of items answered correctly by Student 7 on daily quizzes during hand raising (HR) and response card (RC) conditions.
correct over 7 daily quizzes. During the second hand raising phase
Student 7's mean quiz score was 3.25 items correct with a range of
0-6 items correct over 4 daily quizzes.

**Response Card.** Student 7's mean quiz score during the first
response card phase was 5.8 items correct with a range of 3-10
items correct over 8 daily quizzes. During the second response card
phase Student 7's mean quiz score was 6.3 items correct with a
range of 6-7 items correct over 3 daily quizzes.

**Student 8**

Figure 24 shows Student 8's performance on the daily 16
-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 8's mean quiz score during the first
hand raising phase was 12 items correct with a range of 9-15 items
correct over 8 daily quizzes. During the second hand raising phase
Student 8's mean quiz score was 11.25 items correct with a range
of 7-14 items correct over 4 daily quizzes.

**Response Card.** Student 8's mean quiz score during the first
response card phase was 12.2 items correct with a range of 9-15
items correct over 6 daily quizzes. During the second response card
Figure 24. Number of items answered correctly by Student 8 on daily quizzes during hand raising (HR) and response card (RC) conditions.
phase Student 8’s mean quiz score was 14 items correct with a range of 12-15 items correct over 3 daily quizzes.

**Student 9**

Figure 25 shows Student 9’s performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 9’s mean quiz score during the first hand raising phase was 9.2 items correct with a range of 6-12 items correct over 8 daily quizzes. During the second hand raising phase Student 9’s mean quiz score was 5.3 items correct with a range of 1-12 items correct over 3 daily quizzes.

**Response Card.** Student 9’s mean quiz score during the first response card phase was 12 items correct with a range of 7-15 items correct over 8 daily quizzes. During the second response card phase Student 9’s mean quiz score was 6.5 items correct with a range of 6-7 items correct over 4 daily quizzes.

**Student 10**

Figure 26 shows Student 10’s performance on the daily 16-item quizzes across sessions by experimental phase.
Figure 25. Number of items answered correctly by Student 9 on daily quizzes during hand raising (HR) and response card (RC) conditions.

Figure 26. Number of items answered correctly by Student 10 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Hand Raising. Student 10's mean quiz score during the first hand raising phase was 9.3 items correct with a range of 2-16 items correct over 6 daily quizzes. During the second hand raising phase Student 10's mean quiz score was 10 items correct with a range of 4-15 items correct over 4 daily quizzes.

Response Card. Student 10's mean quiz score during the first response card phase was 12.7 items correct with a range of 10-16 items correct over 7 daily quizzes. During the second response card phase Student 10's mean quiz score was 13.7 items correct with a range of 11-15 items correct over 4 daily quizzes.

Student 11

Figure 27 shows Student 11's performance on the daily 16-item quizzes across sessions by experimental phase.

Hand Raising. Student 11's mean quiz score during the first hand raising phase was 14 items correct with a range of 11-16 items correct over 9 daily quizzes. During the second hand raising phase Student 11's mean quiz score was 14 items correct with a range of 13-15 items correct over 4 daily quizzes.
Figure 27. Number of items answered correctly by Student 11 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Response Card. Student 11's mean quiz score during the first response card phase was 14.2 items correct with a range of 12-16 items correct over 9 daily quizzes. During the second response card phase Student 11's mean quiz score was 14.75 items correct with a range of 13-16 items correct over 4 daily quizzes.

Student 12

Figure 28 shows Student 12's performance on the daily 16-item quizzes across sessions by experimental phase.

Hand Raising. Student 12's mean quiz score during the first hand raising phase was 12 items correct with a range of 9-16 items correct over 9 daily quizzes. During the second hand raising phase Student 12's mean quiz score was 11.5 items correct with a range of 10-14 items correct over 4 daily quizzes.

Response Card. Student 12's mean quiz score during the first response card phase was 13 items correct with a range of 9-16 items correct over 9 daily quizzes. During the second response card phase Student 12's mean quiz score was 14.25 items correct with a range of 13-15 items correct over 4 daily quizzes.
Figure 28. Number of items answered correctly by Student 12 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 13

Figure 29 shows Student 13’s performance on the daily 16-item quizzes across sessions by experimental phase.

Hand Raising. Student 13’s mean quiz score during the first hand raising phase was 10.7 items correct with a range of 8-15 items correct over 8 daily quizzes. During the second hand raising phase Student 13’s mean quiz score was 12.25 items correct with a range of 10-14 items correct over 4 daily quizzes.

Response Card. Student 13’s mean quiz score during the first response card phase was 12.1 items correct with a range of 9-16 items correct over 9 daily quizzes. During the second response card phase Student 13’s mean quiz score was 12.3 items correct with a range of 9-14 items correct over 4 daily quizzes.

Student 14

Figure 30 shows Student 14’s performance on the daily 16-item quizzes across sessions by experimental phase.

Hand Raising. Student 14’s mean quiz score during the first hand raising phase was 7.5 items correct with a range of 5-10 items correct over 8 daily quizzes. During the second hand raising
Figure 29. Number of items answered correctly by Student 13 on daily quizzes during hand raising (HR) and response card (RC) conditions.

Figure 30. Number of items answered correctly by Student 14 on daily quizzes during hand raising (HR) and response card (RC) conditions.
phase Student 7's mean quiz score was 7.5 items correct with a range of 6-7 items correct over 4 daily quizzes.

**Response Card.** Student 14's mean quiz score during the first response card phase was 11.3 items correct with a range of 7-14 items correct over 7 daily quizzes. During the second response card phase Student 14's mean quiz score was 10 items correct with a range of 7-12 items correct over 4 daily quizzes.

**Student 15**

Figure 31 shows Student 15's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 15's mean quiz score during the first hand raising phase was 9.2 items correct with a range of 7-13 items correct over 7 daily quizzes. During the second hand raising phase Student 15's mean quiz score was 9 items correct with a range of 7-11 items correct over 4 daily quizzes.

**Response Card.** Student 15's mean quiz score during the first response card phase was 10.1 items correct with a range of 8-12 items correct over 8 daily quizzes. During the second response card phase Student 15's mean quiz score was 10.25 items correct with a
Figure 31. Number of items answered correctly by Student 15 on daily quizzes during hand raising (HR) and response card (RC) conditions.
range of 7-14 items correct over 4 daily quizzes.

**Student 16**

Figure 32 shows Student 16's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 16's mean quiz score during the first hand raising phase was 13.3 items correct with a range of 10-16 items correct over 9 daily quizzes. During the second hand raising phase Student 16's mean quiz score was 13 items correct with a range of 12-15 items correct over 4 daily quizzes.

**Response Card.** Student 16's mean quiz score during the first response card phase was 15.1 items correct with a range of 14-16 items correct over 9 daily quizzes. During the second response card phase Student 16's mean quiz score was 14.25 items correct with a range of 12-16 items correct over 4 daily quizzes.

**Student 17**

Figure 33 shows Student 17's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 17's mean quiz score during the first hand raising phase was 9.1 items correct with a range of 5-11
Figure 3.2. Number of items answered correctly by Student 16 on daily quizzes during hand raising (HR) and response card (RC) conditions.

Figure 3.3. Number of items answered correctly by Student 17 on daily quizzes during hand raising (HR) and response card (RC) conditions.
items correct over 9 daily quizzes. During the second hand raising phase Student 17’s mean quiz score was 8.5 items correct with a range of 7-10 items correct over 4 daily quizzes.

Response Card. Student 17’s mean quiz score during the first response card phase was 11.2 items correct with a range of 8-14 items correct over 4 daily quizzes. During the second response card phase Student 17’s mean quiz score was 11.25 items correct with a range of 9-15 items correct over 4 daily quizzes.

Student 18

Figure 34 shows Student 18’s performance on the daily 16-item quizzes across sessions by experimental phase.

Hand Raising. Student 18’s mean quiz score during the first hand raising phase was 9.2 items correct with a range of 4-12 items correct over 7 daily quizzes. During the second hand raising phase Student 18’s mean quiz score was 2 items on one quiz.

Response Card. Student 18’s mean quiz score during the first response card phase was 11.2 items correct with a range of 7-14 items correct over 5 daily quizzes. During the second response card phase Student 18’s mean quiz score was 13 items correct with a
Figure 34. Number of items answered correctly by Student 18 on daily quizzes during hand raising (HR) and response card (RC) conditions.
range of 8-15 items correct over 4 daily quizzes.

**Student 19**

Figure 35 shows Student 19's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 19's mean quiz score during the first hand raising phase was 8.7 items correct with a range of 6-12 items correct over 8 daily quizzes. During the second hand raising phase Student 19's mean quiz score was 9 items correct with a range of 7-12 items correct over 3 daily quizzes.

**Response Card.** Student 19's mean quiz score during the first response card phase was 12.2 items correct with a range of 9-16 items correct over 9 daily quizzes. During the second response card phase Student 19's mean quiz score was 12.5 items correct with a range of 12-13 items correct over 2 daily quizzes.

**Student 20**

Figure 36 shows Student 20's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 20's mean quiz score during the first hand raising phase was 6.1 items correct with a range of 4-9 items
Figure 3.5 Number of items answered correctly by Student 19 on daily quizzes during hand raising (HR) and response card (RC) conditions.

Figure 3.6 Number of items answered correctly by Student 20 on daily quizzes during hand raising (HR) and response card (RC) conditions.
correct over 6 daily quizzes. During the second hand raising phase, Student 20's mean quiz score was 4.5 items correct with a range of 1-9 items correct over 4 daily quizzes.

**Response Card.** Student 20’s mean quiz score during the first response card phase was 7.4 items correct with a range of 4-12 items correct over 9 daily quizzes. During the second response card phase Student 20's mean quiz score was 4.6 items correct with a range of 4-7 items correct over 4 daily quizzes.

**Student 21**

Figure 37 shows Student 21’s performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 21’s mean quiz score during the first hand raising phase was 11.1 items correct with a range of 7-15 items correct over 9 daily quizzes. During the second hand raising phase Student 21's mean quiz score was 4 items correct with a range of 0-8 items correct over 4 daily quizzes.

**Response Card.** Student 21's mean quiz score during the first response card phase was 11.3 items correct with a range of 9-14 items correct over 6 daily quizzes. During the second response card
Figure 37. Number of items answered correctly by Student 21 on daily quizzes during hand raising (HR) and response card (RC) conditions.
phase Student 21's mean quiz score was 9.3 items correct with a range of 9-12 items correct over 3 daily quizzes.

**Student 22**

Figure 38 shows Student 22's performance on the daily 16-item quizzes across sessions by experimental phase.

**Hand Raising.** Student 22's mean quiz score during the first hand raising phase was 8.6 items correct with a range of 5-12 items correct over 9 daily quizzes. During the second hand raising phase Student 22's mean quiz score was 7.75 items correct with a range of 3-13 items correct over 4 daily quizzes.

**Response Card.** Student 22's mean quiz score during the first response card phase was 11 items correct with a range of 7-15 items correct over 8 daily quizzes. During the second response card phase Student 22's mean quiz score was 11.25 items correct with a range of 9-15 items correct over 4 daily quizzes.

**Recognition and Recall Items.**

**Student 1.** Figure 39 shows Student 1's rate of correct items on recognition and recall questions for each quiz across
Figure 38. Number of items answered correctly by Student 22 on daily quizzes during hand raising (HR) and response card (RC) conditions.
experimental phases. During the first hand raising session Student 1's mean score of correct recognition items was 6.7 with a range of 5-8 correct items across 9 quizzes. Student 1's mean score of correct recall items was 5.6 with a range of 4-7 correct items across 9 quizzes.

During the second hand raising phase Student 1's mean score of correct recognition items was 6.3 with a range of 5-8 correct items across 3 quizzes. Student 1's mean score of correct recall items was 5.6 with a range of 4-7 correct items across 3 quizzes.

During the first response card session Student 1's mean score of correct recognition items was 7.1 with a range of 5-8 correct items across 9 quizzes. Student 1's mean score of correct recall items was 7.4 with a range of 5-8 correct items across 9 quizzes.

During the second response card phase Student 1's mean score of correct recognition items was 6.75 with a range of 6-7 correct across 4 quizzes. Student 1's mean score of correct recall items was 6.75 with a range of 4-8 correct items across 4 quizzes.
Figure 39. Number of recall and recognition items answered correctly by Student 1 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 2. Figure 40 shows Student 2’s rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 2’s mean score of 6.9 recognition items correct with a range of 5-8 correct items across 8 quizzes. Student 2 had a mean score of 5.5 recall items correct with a range of 4-8 correct items across 8 quizzes.

During the second hand raising phase Student 2 had a mean score of 5.75 recognition items correct with a range of 3-7 correct across 4 quizzes. Student 2 had a mean score of 5 recall items correct with a range of 3-8 correct items across 4 quizzes.

During the first response card session Student 2 had a mean score of 7.3 recognition items correct with a range of 6-8 correct items across 9 quizzes. Student 2 had a mean score of 7.6 recall items correct with a range of 6-8 correct items across 9 quizzes.

During the second response card phase Student 2 had a mean score of 6.5 recognition items correct with a range of 5-8 correct across 4 quizzes. Student 2 had a mean score of 7.25 recall items correct with a range of 5-8 correct items across 4 quizzes.
Student 2

![Graph showing recall and recognition items](image)

**Figure 40.** Number of recall and recognition items answered correctly by Student 2 on daily quizzes during hand raising (HR) and response card (RC) conditions.
**Student 3.** Figure 41 shows Student 3’s rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 3’s mean score was 4.5 recognition items correct with a range of 0-8 correct items across 6 quizzes. Student 3 had a mean score of 1.8 recall items correct with a range of 0-3 correct items across 6 quizzes.

During the second hand raising phase Student 3’s mean score was 4 recognition items correct with a range of 2-6 correct across 4 quizzes. Student 3 had a mean score of .75 recall items correct with a range of 0-1 correct items across 4 quizzes.

During the first response card session Student 3’s mean score was 3.3 recognition items correct with a range of 1-7 correct items across 9 quizzes. Student 3’s mean score was 2.2 recall items correct with a range of 0-5 correct items across 9 quizzes.

During the second response card phase Student 3’s mean score of correct recognition items was 6.5 with a range of 6-7 correct across 2 quizzes. Student 3’s mean score of correct recall items was 2.5 with a range of 1-4 correct items across 2 quizzes.
Student 3

![Graph showing the number of recall and recognition items answered correctly by Student 3 on daily quizzes during hand raising (HR) and response card (RC) conditions.]

*Figure 41.* Number of recall and recognition items answered correctly by Student 3 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 4. Figure 42 shows Student 4's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 4's mean score of correct recognition items was 3.2 with a range of 1-5 correct items across 9 quizzes. Student 4's mean score of correct recall items was 1.3 with a range of 0-3 correct items across 9 quizzes.

During the second hand raising phase Student 4's mean score of correct recognition items was 4.5 with a range of 0-6 correct across 3 quizzes. Student 4's mean score of correct recall items was .66 with a range of 0-2 correct items across 3 quizzes.

During the first response card session Student 4's mean score of correct recognition items was 4.25 with a range of 3-7 correct items across 8 quizzes. Student 4's mean score of correct recall items was 2.25 with a range of 1-5 correct items across 8 quizzes.

During the second response card phase Student 4's score of correct recognition items was 5 on one quiz. Student 4's score of correct recall items was 1 on one quiz.
**Figure 4.2** Number of recall and recognition items answered correctly by Student 4 on daily quizzes during hand raising (HR) and response card (RC) conditions.
**Student 5.** Figure 43 shows Student 5’s rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 5’s mean score of correct recognition items was 6 with a range of 6-8 correct items across 9 quizzes. Student 5’s mean score of correct recall items was 5.3 with a range of 3-8 correct items across 9 quizzes.

During the second hand raising phase Student 5’s mean score of correct recognition items was 6.5 with a range of 6-8 correct across 4 quizzes. Student 5’s mean score of correct recall items was 5.75 with a range of 5-7 correct items across 4 quizzes.

During the first response card session Student 5’s mean score of correct recognition items was 7.1 with a range of 5-8 correct items across 9 quizzes. Student 5’s mean score of correct recall items was 7.4 with a range of 6-8 correct items across 9 quizzes.

During the second response card phase Student 5’s mean score of correct recognition items was 7.25 with a range of 6-8 correct across 4 quizzes. Student 5’s mean score of correct recall items was 6.75 with a range of 5-8 correct items across 4 quizzes.
Figure 4.3. Number of recall and recognition items answered correctly by Student 5 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 6. Figure 44 shows Student 6’s rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 6’s mean score of correct recognition items was 4.6 with a range of 2-6 correct items across 5 quizzes. Student 6’s mean score of correct recall items was 1.8 with a range of 2-6 correct items across 5 quizzes.

During the second hand raising phase Student 6’s mean score of correct recognition items was 3.25 with a range of 0-7 correct across 4 quizzes. Student 6’s mean score of correct recall items was 1.75 with a range of 0-5 correct items across 4 quizzes.

During the first response card session Student 6’s mean score of correct recognition items was 4.4 with a range of 3-7 correct items across 8 quizzes. Student 6’s mean score of correct recall items was 3.3 with a range of 2-6 correct items across 8 quizzes.

During the second response card phase Student 6’s mean score of correct recognition items was 6 with a range of 5-7 correct across 2 quizzes. Student 6’s mean score of correct recall items was 2 with a range of 0-4 correct items across 2 quizzes.
**Figure 44.** Number of recall and recognition items answered correctly by Student 6 on daily quizzes during hand raising (HR) and response card (RC) conditions.
**Student 7.** Figure 45 shows Student 7's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 7's mean score of correct recognition items was 2 with a range of 0-6 correct items across 7 quizzes. Student 7's mean score of correct recall items was .71 with a range of 0-3 correct items across 7 quizzes.

During the second hand raising phase Student 7's mean score of correct recognition items was 3 with a range of 0-5 correct across 4 quizzes. Student 7's mean score of correct recall items was .25 with a range of 0-1 correct items across 4 quizzes.

During the first response card session Student 7's mean score of correct recognition items was 4.6 with a range of 3-7 correct items across 8 quizzes. Student 7's mean score of correct recall items was .87 with a range of 0-3 correct items across 8 quizzes.

During the second response card phase Student 7's mean score of correct recognition items was 5.6 with a range of 4-7 correct across 3 quizzes. Student 3's mean score of correct recall items was .66 with a range of 0-2 correct items across 3 quizzes.
Figure 4.5  Number of recall and recognition items answered correctly by Student 7 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 8. Figure 46 shows Student 8's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 8's mean score of correct recognition items was 6.5 with a range of 5-8 correct items across 7 quizzes. Student 8's mean score of correct recall items was 5.5 with a range of 4-7 correct items across 7 quizzes.

During the second hand raising phase Student 8's mean score of correct recognition items was 6.75 with a range of 6-8 correct across 4 quizzes. Student 8's mean score of correct recall items was 4.5 with a range of 1-6 correct items across 4 quizzes.

During the first response card session Student 8's mean score of correct recognition items was 6.6 with a range of 4-8 correct items across 6 quizzes. Student 8's mean score of correct recall items was 6 with a range of 4-7 correct items across 6 quizzes.

During the second response card phase Student 8's mean score of correct recognition items was 7.3 with a range of 7-8 correct across 3 quizzes. Student 8's mean score of correct recall items was 6.6 with a range of 5-8 correct items across 3 quizzes.
Figure 46. Number of recall and recognition items answered correctly by Student 8 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 9. Figure 47 shows Student 9's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 9's mean score of correct recognition items was 5.75 with a range of 4-8 correct items across 8 quizzes. Student 9's mean score of correct recall items was 3.9 with a range of 2-7 correct items across 8 quizzes.

During the second hand raising phase Student 9's mean score of correct recognition items was 3 with a range of 0-6 correct across 3 quizzes. Student 9's mean score of correct recall items was 2.6 with a range of 1-6 correct items across 3 quizzes.

During the first response card session Student 9's mean score of correct recognition items was 5.9 with a range of 2-8 correct items across 8 quizzes. Student 9's mean score of correct recall items was 6 with a range of 2-8 correct items across 8 quizzes.

During the second response card phase Student 9's mean score of correct recognition items was 5 with a range of 4-6 correct across 4 quizzes. Student 9's mean score of correct recall items was 1.5 with a range of 0-3 correct items across 4 quizzes.
Figure 47. Number of recall and recognition items answered correctly by Student 9 on daily quizzes during hand raising (HR) and response card (RC) conditions.
Student 10. Figure 48 shows Student 10's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 10's mean score of correct recognition items was 5.6 with a range of 2-8 correct items across 6 quizzes. Student 10's mean score of correct recall items was 3.6 with a range of 0-8 correct items across 8 quizzes.

During the second hand raising phase Student 10's mean score of correct recognition items was 6.5 with a range of 4-8 correct across 4 quizzes. Student 10's mean score of correct recall items was 3.5 with a range of 0-7 correct items across 4 quizzes.

During the first response card session Student 10's mean score of correct recognition items was 6.7 with a range of 6-8 correct items across 7 quizzes. Student 10's mean score of correct recall items was 6.1 with a range of 4-8 correct items across 7 quizzes.

During the second response card phase Student 10's mean score of correct recognition items was 7.5 with a range of 6-8 correct across 4 quizzes. Student 10's mean score of correct recall items was 6.4 with a range of 5-7 correct items across 4 quizzes.
Student 10

Figure 48. Number of recall and recognition items answered correctly by Student 10 on daily quizzes during hand raising (HR) and response card (RC) conditions.
items was 6.25 with a range of 5-7 correct items across 4 quizzes.

**Student 11.** Figure 49 shows Student 11’s rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 11’s mean score of correct recognition items was 7.3 with a range of 5-8 correct items across 9 quizzes. Student 11’s mean score of correct recall items was 6.6 with a range of 5-8 correct items across 9 quizzes.

During the second hand raising phase Student 11’s mean score of correct recognition items was 7.5 with a range of 7-8 correct across 4 quizzes. Student 11’s mean score of correct recall items was 6.5 with a range of 6-7 correct items across 4 quizzes.

During the first response card session Student 11’s mean score of correct recognition items was 7.1 with a range of 6-8 correct items across 9 quizzes. Student 11’s mean score of correct recall items was 6.2 with a range of 6-8 correct items across 9 quizzes.

During the second response card phase Student 11’s mean score of correct recognition items was 7.5 with a range of 7-8
Figure 49. Number of recall and recognition items answered correctly by Student 11 on daily quizzes during hand raising (HR) and response card (RC) conditions.
correct across 4 quizzes. Student 11's mean score of correct recall items was 7.2 with a range of 6-8 correct items across 4 quizzes.

**Student 12.** Figure 50 shows Student 12's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 12's mean score of correct recognition items was 6.3 with a range of 4-8 correct items across 9 quizzes. Student 12's mean score of correct recall items was 5.6 with a range of 3-8 correct items across 9 quizzes.

During the second hand raising phase Student 12's mean score of correct recognition items was 7.2 with a range of 6-8 correct across 4 quizzes. Student 12's mean score of correct recall items was 4 with a range of 6-8 correct items across 4 quizzes.

During the first response card session Student 12's mean score of correct recognition items was 7 with a range of 6-8 correct items across 9 quizzes. Student 12's mean score of correct recall items was 6 with a range of 3-8 correct items across 9 quizzes.

During the second response card phase Student 12's mean score of correct recognition items was 7.75 with a range of 7-8
Figure 50. Number of recall and recognition items answered correctly by Student 12 on daily quizzes during hand raising (HR) and response card (RC) conditions.
correct across 4 quizzes. Student 12's mean score of correct recall items was 6.5 with a range of 5-8 correct items across 4 quizzes.

**Student 13.** Figure 51 shows Student 13's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 13's mean score of correct recognition items was 6.75 with a range of 5-8 correct items across 8 quizzes. Student 13's mean score of correct recall items was 4.1 with a range of 5-8 correct items across 8 quizzes.

During the second hand raising phase Student 13's mean score of correct recognition items was 6.75 with a range of 5-8 correct across 4 quizzes. Student 13's mean score of correct recall items was 5.5 with a range of 4-7 correct items across 4 quizzes.

During the first response card session Student 13's mean score of correct recognition items was 5.7 with a range of 2-8 correct items across 9 quizzes. Student 13's mean score of correct recall items was 6.4 with a range of 3-8 correct items across 9 quizzes.
Figure 51. Number of recall and recognition items answered correctly by Student 13 on daily quizzes during hand raising (HR) and response card (RC) conditions.
During the second response card phase Student 13's mean score of correct recognition items was 6 with a range of 4-8 correct across 4 quizzes. Student 13's mean score of correct recall items was 6 with a range of 5-8 correct items across 4 quizzes.

Student 14. Figure 52 shows Student 14's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 14's mean score of correct recognition items was 5.2 with a range of 4-8 correct items across 9 quizzes. Student 14's mean score of correct recall items was 3.3 with a range of 1-8 correct items across 9 quizzes.

During the second hand raising phase Student 14's mean score of correct recognition items was 5 with a range of 5-5 correct across 4 quizzes. Student 14's mean score of correct recall items was 1.5 with a range of 1-2 correct items across 4 quizzes.

During the first response card session Student 14's mean score of correct recognition items was 6.1 with a range of 5-7 correct items across 7 quizzes. Student 14's mean score of correct
Student 14

Figure 5.2. Number of recall and recognition items answered correctly by Student 14 on daily quizzes during hand raising (HR) and response card (RC) conditions.
recall items was 5.1 with a range of 2-7 correct items across 7 quizzes.

During the second response card phase Student 14's mean score of correct recognition items was 6.25 with a range of 5-7 correct across 4 quizzes. Student 14's mean score of correct recall items was 3.75 with a range of 1-5 correct items across 4 quizzes.

Student 15. Figure 53 shows Student 15's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 15's mean score of correct recognition items was 5.8 with a range of 4-8 correct items across 7 quizzes. Student 15's mean score of correct recall items was 3.2 with a range of 1-5 correct items across 7 quizzes.

During the second hand raising phase Student 15's mean score of correct recognition items was 5.5 with a range of 4-7 correct across 4 quizzes. Student 15's mean score of correct recall items was 3.5 with a range of 3-4 correct items across 4 quizzes.

During the first response card session Student 15's mean score of correct recognition items was 5 with a range of 3-7 correct
Figure 5.3. Number of recall and recognition items answered correctly by Student 15 on daily quizzes during hand raising (HR) and response card (RC) conditions.
items across 8 quizzes. Student 15’s mean score of correct recall items was 4.5 with a range of 3-5 correct items across 8 quizzes.

During the second response card phase Student 15’s mean score of correct recognition items was 5.5 with a range of 3-8 correct across 4 quizzes. Student 15’s mean score of correct recall items was 4.75 with a range of 1-7 correct items across 4 quizzes.

**Student 16.** Figure 54 shows Student 16’s rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 16’s mean score of correct recognition items was 7.5 with a range of 6-8 correct items across 9 quizzes. Student 16’s mean score of correct recall items was 5.6 with a range of 4-7 correct items across 9 quizzes.

During the second hand raising phase Student 16’s mean score of correct recognition items was 7.25 with a range of 6-8 correct across 4 quizzes. Student 16’s mean score of correct recall items was 5.75 with a range of 5-7 correct items across 4 quizzes.
Student 16

Figure 54. Number of recall and recognition items answered correctly by Student 16 on daily quizzes during hand raising (HR) and response card (RC) conditions.
During the first response card session Student 16's mean score of correct recognition items was 7.7 with a range of 7-8 correct items across 9 quizzes. Student 16's mean score of correct recall items was 7.2 with a range of 6-8 correct items across 9 quizzes.

During the second response card phase Student 16's mean score of correct recognition items was 7 with a range of 6-8 correct across 4 quizzes. Student 16's mean score of correct recall items was 6.75 with a range of 4-8 correct items across 4 quizzes.

**Student 17.** Figure 55 shows Student 17's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 17's mean score of correct recognition items was 6.2 with a range of 3-8 correct items across 9 quizzes. Student 17's mean score of correct recall items was 3.4 with a range of 2-6 correct items across 9 quizzes.

During the second hand raising phase Student 17's mean score of correct recognition items was 5.75 with a range of 5-6 correct across 4 quizzes. Student 17's mean score of correct recall
Figure 5.5. Number of recall and recognition items answered correctly by Student 17 on daily quizzes during hand raising (HR) and response card (RC) conditions.
items was 2.75 with a range of 1-5 correct items across 4 quizzes.

During the first response card session Student 17's mean score of correct recognition items was 6.75 with a range of 5-8 correct items across 4 quizzes. Student 17's mean score of correct recall items was 5 with a range of 3-7 correct items across 4 quizzes.

During the second response card phase Student 17's mean score of correct recognition items was 6.75 with a range of 6-8 correct across 4 quizzes. Student 17's mean score of correct recall items was 4.5 with a range of 3-7 correct items across 4 quizzes.

**Student 18.** Figure 56 shows Student 18's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 18's mean score of correct recognition items was 5.7 with a range of 3-7 correct items across 7 quizzes. Student 18's mean score of correct recall items was 3.1 with a range of 2-6 correct items across 7 quizzes.

During the second hand raising phase Student 18's score of correct recognition items was 0 one quiz. Student 18's score of
Figure 56. Number of recall and recognition items answered correctly by Student 18 on daily quizzes during hand raising (HR) and response card (RC) conditions.
correct recall items was 1 on one quiz.

During the first response card session Student 18's mean score of correct recognition items was 5.8 with a range of 3-7 correct items across 6 quizzes. Student 18's mean score of correct recall items was 4 with a range of 1-7 correct items across 6 quizzes.

During the second response card phase Student 18's mean score of correct recognition items was 7.25 with a range of 6-8 correct across 4 quizzes. Student 18's mean score of correct recall items was 7 with a range of 6-8 correct items across 4 quizzes.

**Student 19.** Figure 57 shows Student 19's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 19's mean score of correct recognition items was 6 with a range of 4-8 correct items across 8 quizzes. Student 19's mean score of correct recall items was 3.1 with a range of 1-5 correct items across 8 quizzes.

During the second hand raising phase Student 19's mean score of correct recognition items was 6.75 with a range of 5-8
**Figure 57.** Number of recall and recognition items answered correctly by Student 19 on daily quizzes during hand raising (HR) and response card (RC) conditions.
correct across 4 quizzes. Student 19's mean score of correct recall items was 3.75 with a range of 1-7 correct items across 4 quizzes.

During the first response card session Student 19's mean score of correct recognition items was 6.3 with a range of 5-8 correct items across 9 quizzes. Student 19's mean score of correct recall items was 5.7 with a range of 3-7 correct items across 9 quizzes.

During the second response card phase Student 19's mean score of correct recognition items was 7.5 with a range of 7-8 correct across 2 quizzes. Student 19's mean score of correct recall items was 5 with a range of 4-6 correct items across 2 quizzes.

**Student 20.** Figure 58 shows Student 20's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 20's mean score of correct recognition items was 4.1 with a range of 2-8 correct items across 6 quizzes. Student 20's mean score of correct recall items was .25 with a range of 0-4 correct items across 6 quizzes.
**Figure 58.** Number of recall and recognition items answered correctly by Student 20 on daily quizzes during hand raising (HR) and response card (RC) conditions.
During the second hand raising phase Student 20's mean score of correct recognition items was 3.5 with a range of 1-7 correct across 4 quizzes. Student 20's mean score of correct recall items was 1 with a range of 0-2 correct items across 4 quizzes.

During the first response card session Student 20’s mean score of correct recognition items was 5 with a range of 3-7 correct items across 9 quizzes. Student 20’s mean score of correct recall items was 2.4 with a range of 1-5 correct items across 9 quizzes.

During the second response card phase Student 20's mean score of correct recognition items was 4.75 with a range of 3-6 correct across 4 quizzes. Student 20's mean score of correct recall items was 1 with a range of 0-2 correct items across 4 quizzes.

**Student 21.** Figure 59 shows Student 21's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 21's mean score of correct recognition items was 6.1 with a range of 4-8 correct items across 9 quizzes. Student 21's mean score of correct recall items was 5 with a range of 3-7 correct items across 9 quizzes.
Figure 59. Number of recall and recognition items answered correctly by Student 21 on daily quizzes during hand raising (HR) and response card (RC) conditions.
During the second hand raising phase Student 21's mean score of correct recognition items was 3.25 with a range of 0-7 correct across 4 quizzes. Student 21's mean score of correct recall items was .75 with a range of 0-2 correct items across 4 quizzes.

During the first response card session Student 21's mean score of correct recognition items was 6.2 with a range of 4-8 correct items across 6 quizzes. Student 21's mean score of correct recall items was 5.2 with a range of 4-8 correct items across 6 quizzes.

During the second response card phase Student 21's mean score of correct recognition items was 5 with a range of 4-6 correct across 3 quizzes. Student 21's mean score of correct recall items was 4 with a range of 3-6 correct items across 3 quizzes.

**Student 22.** Figure 60 shows Student 22's rate of correct items on recognition and recall questions for each quiz across experimental phases. During the first hand raising session Student 22's mean score of correct recognition items was 5.4 with a range of 2-7 correct items across 9 quizzes. Student 22's mean score of correct recall items was 3.2 with a range of 0-6 correct items across
Figure 60. Number of recall and recognition items answered correctly by Student 22 on daily quizzes during hand raising (HR) and response card (RC) conditions.
During the second hand raising phase Student 22's mean score of correct recognition items was 4.5 with a range of 2-6 correct across 4 quizzes. Student 22's mean score of correct recall items was 3.25 with a range of 1-7 correct items across 4 quizzes.

During the first response card session Student 22's mean score of correct recognition items was 5.6 with a range of 3-8 correct items across 8 quizzes. Student 22's mean score of correct recall items was 5.4 with a range of 1-8 correct items across 8 quizzes.

During the second response card phase Student 22's mean score of correct recognition items was 6.5 with a range of 6-8 correct across 4 quizzes. Student 22's mean score of correct recall items was 4.75 with a range of 3-7 correct items across 4 quizzes.

Group Results

Table 5 shows the group performance of students on items instructed during hand raising and response card conditions on daily quizzes.
Table 5

Students' Daily Mean Quiz Scores and Average Grade for Each Experimental Condition.

<table>
<thead>
<tr>
<th>STUDENTS</th>
<th>EXPERIMENTAL CONDITIONS</th>
</tr>
</thead>
<tbody>
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</tr>
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<td>11.1</td>
</tr>
<tr>
<td>NAR Grp.</td>
<td>11.3</td>
</tr>
</tbody>
</table>

| At Risk | | | | | | |
| 3 | 6.25 | 6.8 | 4.75 | 10.5 | 5.5/F | 8.7/F |
| 4 | 4 | 6.5 | 2.75 | 6 | 3.4/F | 6.3/F |
| 6 | 6.4 | 7.7 | 4.75 | 8 | 5.6/F | 7.85/F |
| 7 | 3.2 | 5.8 | 3.2 | 6.3 | 3.2/F | 6.05/F |
| 9 | 9.2 | 12 | 5.3 | 6.5 | 7.7/F | 9.2/F |
| 14 | 7.5 | 11.3 | 7.5 | 10 | 7.5/F | 10.6/D |
| 17 | 9.1 | 11.2 | 8.5 | 11.2 | 8.8/F | 11.2/D+ |
| 20 | 6.1 | 7.4 | 4.5 | 4.6 | 5.3/F | 6/F |
| 22 | 8.6 | 11 | 7.75 | 11.2 | 8.2/F | 11.1/D+ |
| AR Grp. | 7.4 | 8.1 | 5.4 | 6.25 | 6.1/F | 8.5/F |
| Whole Class | 9.7 | 10.9 | 8.1 | 11.1 | 8.3/F | 11.1/D+ |
Daily Quiz

**Hand Raising.** The group mean quiz score during the first hand raising phase was 9.4 correct items over 9 daily quizzes. During the second hand raising phase the group mean quiz score was 8.2 items correct over 4 daily quizzes. The group mean rate for both hand raising phases 8.8 correct items (see Table 5).

**Response Card.** The group mean quiz score during the first response card phase was 11.2 items correct over 9 daily quizzes. During the second response card phase the group mean quiz score was 11.1 items correct over 4 daily quizzes. The group mean for both responses card phases was 11.15 correct items (see Table 5).

**Recognition and Recall Items**

Table 6 shows the group performance of the students on recognition and recall items instructed during hand raising and response card conditions. The group mean for recall items instructed during the first hand raising phase on daily quizzes was 5.5 correct items. The group mean for recognition items instructed during the first hand raising phase on daily quizzes was 3.7 correct items.
Table 6

Students’ Mean Number of Correct Responses to Recall and Recognition Questions on the Daily Quizzes.

<table>
<thead>
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AT RISK

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<td>5/1</td>
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<td>3/26</td>
<td>5/1.5</td>
<td>4.4/3.25</td>
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</tr>
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AT Grp. 4.5/2.2 | 5.1/3.6 | 4/1.6 | 5.8/2.4 | 4/1.6 | 5.6/2.9

Whole Class | 5.6/3.7 | 5.9/5 | 5.3/1 | 6.4/4.6 | 5.1/3.1 | 6.25/5 |

Notes

a = recognition
b = recall
The group mean for recall items instructed during the second hand raising phase on daily quizzes was 3.2 correct items. The group mean for recognition items instructed during the second hand raising phase on daily quizzes was 5.1 correct items.

The group mean for recall items instructed during the first response card phase on daily quizzes was 5.1 correct items. The group mean for recognition items instructed during the first response card phase on daily quizzes was 6.0 correct items.

The group mean for recall items instructed during the second response card phase on daily quizzes was 4.6 correct items. The group mean for recognition items instructed during the second response card phase on daily quizzes was 6.0 correct items.

Unit Tests

Four bi-weekly tests were given to the students during the study. Each units test had a total of 40 items with 20 recall items and 20 recognition items.

Number of Correct Items.

Student 1. Figure 61 shows Student 1's performance on the 40 item bi-weekly unit tests and overall number of correct items.
Figure 6.1. Percentage of items answered by Student 1 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the first unit test covering only items instructed during the first hand raising phase Student 1 scored 31 correct items for a correct percentage of 77.5%. During the second unit test covering items instructed only during the first response card phase Student 1 scored 36 correct items for a correct percentage of 90%.

Items for the third unit test were instructed during both hand raising and response card conditions. Unit test items 1-20 were instructed during response conditions and items 21-40 were instructed during hand raising conditions. Student 1 scored 31 correct items overall for a correct percentage of 77.5%. Student 1 answered 14 hand raising instructed items correctly for a percentage of 70%. Student 1 answered 17 response card items correctly for a 85% accuracy rate.

Items for the fourth unit test were instructed during both hand raising and response card conditions. Unit test items 1-20 were instructed during hand raising and items 21-40 were instructed during response card conditions. Student 1 scored 33 correct items for a overall correct percentage of 82.5%. Student 1 answered 15 hand raising instructed items correctly for a correct
percentage of 75%. Student 1 answered 18 response card items correctly for a correct percentage of 90%.

Student 1 scored a total of 131 items correct on all four unit tests for a correct overall percentage of 82%. Student 1 scored 60 hand raising instructed items correct for all four unit tests for a percentage of 75%. Student 1 scored 71 response card instructed items correct for a percentage of 89%.

**Student 2.** Figure 62 shows Student 2’s performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 2 scored 25 correct items for a correct percentage of 62% (HR). During the second unit test Student 2 scored 38 correct items for a correct percentage of 95% (RC).

During the third unit test Student 2 scored 28 correct items overall for a correct percentage of 70% (RC/HR). Student 2 answered 11 hand raising instructed items correctly for a percentage of 55%. Student 2 answered 17 response card items correctly for a 85% accuracy rate.

During the fourth unit test Student 2 scored 31 correct items for a overall correct percentage of 77.5% (HR/RC). Student 2
Figure 6.2. Percentage of items answered by Student 2 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
answered 14 hand raising instructed items correctly for a correct percentage of 70%. Student 2 answered 17 response card items correctly for a correct percentage of 85%.

Student 2 scored a total of 122 items correct on all four unit tests for a correct overall percentage of 76%. Student 2 answered 50 hand raising instructed items correctly for all four unit tests for a percentage of 63%. Student 2 scored 72 response card instructed items correct for a percentage of 90%.

**Student 3.** Figure 63 shows Student 3's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 3 scored 16 correct items for a correct percentage of 40% (HR). During the second unit test Student 3 scored 26 correct items for a correct percentage of 65% (RC).

During the third unit test Student 3 scored 10 correct items overall for a correct percentage of 25% (RC/HR). Student 3 answered 0 hand raising instructed items correctly for a percentage of 0%. Student 3 answered 10 response card items correctly for a 50% accuracy rate.
Figure 6.3. Percentage of items answered by Student 3 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the fourth unit test Student 3 scored 6 correct items for a overall correct percentage of 15% (HR/RC). Student 3 answered 1 hand raising instructed items correctly for a correct percentage of 5%. Student 3 answered 5 response card items correctly for a correct percentage of 25%.

Student 3 scored a total of 58 items correct on all four unit tests for a correct overall percentage of 36%. Student 3 answered 17 hand raising instructed items correctly for all four unit tests for a percentage of 21%. Student 3 scored 41 response card instructed items correct for a percentage of 36%.

Student 4. Figure 64 shows Student 4's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 4 scored 122 correct items for a correct percentage of 30% (HR). During the second unit test Student 4 scored 23 correct items for a correct percentage of 57.5% (RC).

During the third unit test Student 4 scored 19 correct items overall for a correct percentage of 47.5% (RC/HR). Student 4 answered 9 hand raising instructed items correctly for a percentage of 45%. Student 4 answered 10 response card items
Figure 64. Percentage of items answered by Student 4 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
correctly for a 50% accuracy rate.

During the fourth unit test Student 4 scored 1 correct items for a overall correct percentage of .025% (HR/RC). Student 4 answered 1 hand raising instructed items correctly for a correct percentage of .05%. Student 4 answered 0 response card items correctly for a correct percentage of 0%.

Student 4 scored a total of 55 items correct on all four unit tests for a correct overall percentage of 34%. Student 4 answered 22 hand raising instructed items correctly for all four unit tests for a percentage of 27.5%. Student 4 scored 33 response card instructed items correct for a percentage of 41%.

**Student 5.** Figure 65 shows Student 5's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 5 scored 31 correct items for a correct percentage of 77.5% (HR). During the second unit test Student 5 scored 39 correct items for a correct percentage of 97.5% (RC).

During the third unit test Student 5 scored 37 correct items overall for a correct percentage of 92.5% (RC/HR). Student 5
Figure 6.5. Percentage of items answered by Student 5 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
answered 19 hand raising instructed items correctly for a percentage of 95%. Student 5 answered 18 response card items correctly for a 90% accuracy rate.

During the fourth unit test Student 5 scored 33 correct items for a overall correct percentage of 82.5% (HR/RC). Student 5 answered 14 hand raising instructed items correctly for a correct percentage of 70%. Student 5 answered 19 response card items correctly for a correct percentage of 95%.

Student 5 scored a total of 140 items correct on all four unit tests for a correct overall percentage of 87.5%. Student 5 answered 64 hand raising instructed items correctly for all four unit tests for a percentage of 80%. Student 5 scored 76 response card instructed items correct for a percentage of 95%.

Student 6. Figure 66 shows Student 6's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 6 scored 13 correct items for a correct percentage of 32.5% (HR). During the second unit test Student 6 scored 30 correct items for a correct percentage of 75% (RC).
Figure 66. Percentage of items answered by Student 6 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the third unit test Student 6 scored 34 correct items overall for a correct percentage of 85% (RC/HR). Student 6 answered 15 hand raising instructed items correctly for a percentage of 75%. Student 6 answered 19 response card items correctly for a 95% accuracy rate.

During the fourth unit test Student 6 scored 3 correct items for a overall correct percentage of 7.5% (HR/RC). Student 6 answered 3 hand raising instructed items correctly for a correct percentage of 15%. Student 6 answered 0 response card items correctly for a correct percentage of 0%.

Student 6 scored a total of 80 items correct on all four unit tests for a correct overall percentage of 50%. Student 6 answered 31 hand raising instructed items correctly for all four unit tests for a percentage of 39%. Student 6 scored 49 response card instructed items correct for a percentage of 61%.

Student 7. Figure 67 shows Student 7’s performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 7 scored 4 correct items for a correct percentage of 20% (HR). During the second unit test Student
Figure 67. Percentage of items answered by Student 7 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
2 scored 21 correct items for a correct percentage of 52% (RC).

During the third unit test Student 7 scored 6 correct items overall for a correct percentage of 15% (RC/HR). Student 7 answered 1 hand raising instructed items correctly for a percentage of 5%. Student 5 answered 5 response card items correctly for a 25% rate.

During the fourth unit test Student 7 scored 0 correct items for a overall correct percentage of 0% (HR/RC). Student 7 answered 0 hand raising instructed items correctly for a correct percentage of 0%. Student 7 answered 0 response card items correctly for a correct percentage of 0%.

Student 7 scored a total of 31 items correct on all four unit tests for a correct overall percentage of 19%. Student 7 answered 5 hand raising instructed items correctly for all four unit tests for a percentage of 6%. Student 7 scored 26 response card instructed items correct for a percentage of 32.5%.

**Student 8.** Figure 68 shows Student 8’s performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 8 scored 30 correct items for a
Figure 6.8. Percentage of items answered by Student 8 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
correct percentage of 75% (HR). During the second unit test, Student 8 scored 33 correct items for a correct percentage of 82.5% (RC).

During the third unit test, Student 8 scored 32 correct items overall for a correct percentage of 80% (RC/HR). Student 8 answered 15 hand raising instructed items correctly for a percentage of 75%. Student 8 answered 17 response card items correctly for a 85% accuracy rate.

During the fourth unit test, Student 8 scored 27 correct items for an overall correct percentage of 67.5% (HR/RC). Student 8 answered 12 hand raising instructed items correctly for a correct percentage of 60%. Student 8 answered 15 response card items correctly for a correct percentage of 75%.

Student 8 scored a total of 122 items correct on all four unit tests for a correct overall percentage of 76%. Student 8 answered 57 hand raising instructed items correctly for all four unit tests for a percentage of 71%. Student 8 scored 65 response card instructed items correct for a percentage of 81%.
Student 9. Figure 69 shows Student 9's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 9 scored 13 correct items for a correct percentage of 32.5% (HR). During the second unit test Student 9 scored 23 correct items for a correct percentage of 57.5% (RC).

During the third unit test Student 9 scored 13 correct items overall for a correct percentage of 32.5% (RC/HR). Student 9 answered 5 hand raising instructed items correctly for a percentage of 25%. Student 9 answered 8 response card items correctly for a 40% accuracy rate.

During the fourth unit test Student 9 scored 14 correct items for a overall correct percentage of 35% (HR/RC). Student 9 answered 5 hand raising instructed items correctly for a correct percentage of 25%. Student 9 answered 9 response card items correctly for a correct percentage of 45%.

Student 9 scored a total of 63 items correct on all four unit tests for a correct overall percentage of 39%. Student 9 answered 23 hand raising instructed items correctly for all four unit tests for
Figure 69. Percentage of items answered by Student 9 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
a percentage of 28%. Student 9 scored 40 response card instructed items correct for a percentage of 50%.

**Student 10.** Figure 70 shows Student 10's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 10 scored 7 correct items for a correct percentage of 17.5% (HR). During the second unit test Student 10 scored 36 correct items for a correct percentage of 90% (RC).

During the third unit test Student 10 scored 16 correct items overall for a correct percentage of 40% (RC/HR). Student 10 answered 1 hand raising instructed items correctly for a percentage of 5%. Student 10 answered 15 response card items correctly for a 75% accuracy rate.

During the fourth unit test Student 10 scored 33 correct items for a overall correct percentage of 82.5% (HR/RC). Student 10 answered 14 hand raising instructed items correctly for a correct percentage of 70%. Student 10 answered 19 response card items correctly for a correct percentage of 95%.
Figure 70. Percentage of items answered by Student 10 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
Student 10 scored a total of 92 items correct on all four unit tests for a correct overall percentage of 57.5%. Student 10 answered 22 hand raising instructed items correctly for all four unit tests for a percentage of 28%. Student 10 scored 70 response card instructed items correct for a percentage of 88%.

Student 11. Figure 71 shows Student 11’s performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 11 scored 35 correct items for a correct percentage of 87.5% (HR). During the second unit test Student 11 scored 39 correct items for a correct percentage of 97.5% (RC).

During the third unit test Student 11 scored 36 correct items overall for a correct percentage of 90% (RC/HR). Student 11 answered 17 hand raising instructed items correctly for a percentage of 85%. Student 11 answered 19 response card items correctly for a 95% accuracy rate.

During the fourth unit test Student 11 scored 32 correct items for a overall correct percentage of 80% (HR/RC). Student 11 answered 13 hand raising instructed items correctly for a correct
Figure 7. Percentage of items answered by Student 11 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
percentage of 65%. Student 11 answered 19 response card items correctly for a correct percentage of 95%.

Student 11 scored a total of 142 items correct on all four unit tests for a correct overall percentage of 88.7%. Student 11 answered 65 hand raising instructed items correctly for all four unit tests for a percentage of 81%. Student 11 scored 77 response card instructed items correct for a percentage of 96%.

Student 12. Figure 72 shows Student 12's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 12 scored 31 correct items for a correct percentage of 77.5% (HR). During the second unit test Student 12 scored 29 correct items for a correct percentage of 72.5% (RC).

During the third unit test Student 12 scored 30 correct items overall for a correct percentage of 75% (RC/HR). Student 12 answered 14 hand raising instructed items correctly for a percentage of 70%. Student 12 answered 16 response card items correctly for a 80% accuracy rate.
Figure 72. Percentage of items answered by Student 12 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the fourth unit test Student 12 scored 27 correct items for an overall correct percentage of 67.5% (HR/RC). Student 12 answered 10 hand raising instructed items correctly for a correct percentage of 50%. Student 12 answered 17 response card items correctly for a correct percentage of 85%.

Student 12 scored a total of 117 items correct on all four unit tests for a correct overall percentage of 73%. Student 12 answered 55 hand raising instructed items correctly for all four unit tests for a percentage of 69%. Student 12 scored 62 response card instructed items correct for a percentage of 78%.

**Student 13.** Figure 73 shows Student 13's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 13 scored 28 correct items for a correct percentage of 70% (HR). During the second unit test Student 13 scored 39 correct items for a correct percentage of 97.5% (RC).

During the third unit test Student 13 scored 34 correct items overall for a correct percentage of 85% (RC/HR). Student 13 answered 16 hand raising instructed items correctly for a
Figure 7.3. Percentage of items answered by Student 13 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
percentage of 80%. Student 13 answered 18 response card items correctly for a 90% accuracy rate.

During the fourth unit test Student 13 scored 28 correct items for a overall correct percentage of 70% (HR/RC). Student 13 answered 13 hand raising instructed items correctly for a correct percentage of 65%. Student 13 answered 15 response card items correctly for a correct percentage of 75%.

Student 13 scored a total of 129 items correct on all four unit tests for a correct overall percentage of 80%. Student 13 answered 57 hand raising instructed items correctly for all four unit tests for a percentage of 71%. Student 13 scored 72 response card instructed items correct for a percentage of 90%.

**Student 14.** Figure 74 shows Student 14's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 14 scored 18 correct items for a correct percentage of 45% (HR). During the second unit test Student 14 scored 30 correct items for a correct percentage of 75% (RC).
Figure 74. Percentage of items answered by Student 14 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the third unit test Student 14 scored 20 correct items overall for a correct percentage of 50% (RC/HR). Student 14 answered 6 hand raising instructed items correctly for a percentage of 30%. Student 14 answered 14 response card items correctly for a 70% accuracy rate.

During the fourth unit test Student 14 scored 14 correct items for a overall correct percentage of 35% (HR/RC). Student 14 answered 8 hand raising instructed items correctly for a correct percentage of 40%. Student 14 answered 6 response card items correctly for a correct percentage of 30%.

Student 2 scored a total of 82 items correct on all four unit tests for a correct overall percentage of 51%. Student 14 answered 32 hand raising instructed items correctly for all four unit tests for a percentage of 40%. Student 2 scored 50 response card instructed items correct for a percentage of 63%.

**Student 15.** Figure 75 shows Student 15's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 15 scored 17 correct items for a correct percentage of 42% (HR). During the second unit test
Figure 75. Percentage of items answered by Student 15 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
Student 15 scored 30 correct items for a correct percentage of 75% (RC).

During the third unit test Student 15 scored 24 correct items overall for a correct percentage of 60% (RC/HR). Student 15 answered 10 hand raising instructed items correctly for a percentage of 50%. Student 15 answered 14 response card items correctly for a 70% accuracy rate.

During the fourth unit test Student 15 scored 21 correct items for a overall correct percentage of 52.5% (HR/RC). Student 15 answered 9 hand raising instructed items correctly for a correct percentage of 45%. Student 15 answered 12 response card items correctly for a correct percentage of 60%.

Student 15 scored a total of 92 items correct on all four unit tests for a correct overall percentage of 57.5%. Student 15 answered 36 hand raising instructed items correctly for all four unit tests for a percentage of 45%. Student 15 scored 56 response card instructed items correct for a percentage of 70%.

Student 16. Figure 76 shows Student 16's performance on the 40 item bi-weekly unit tests and overall number of correct
Figure 76. Percentage of items answered by Student 16 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
items. During the first unit test Student 16 scored 30 correct items for a correct percentage of 75% (HR). During the second unit test Student 16 scored 39 correct items for a correct percentage of 97.5% (RC).

During the third unit test Student 16 scored 34 correct items overall for a correct percentage of 85% (RC/HR). Student 16 answered 16 hand raising instructed items correctly for a percentage of 80%. Student 16 answered 18 response card items correctly for a 90% accuracy rate.

During the fourth unit test Student 16 scored 36 correct items for an overall correct percentage of 90% (HR/RC). Student 16 answered 17 hand raising instructed items correctly for a correct percentage of 85%. Student 16 answered 19 response card items correctly for a correct percentage of 95%.

Student 16 scored a total of 139 items correct on all four unit tests for a correct overall percentage of 87%. Student 16 answered 63 hand raising instructed items correctly for all four unit tests for a percentage of 79%. Student 16 scored 76 response card instructed items correct for a percentage of 95%.
Student 17. Figure 77 shows Student 17's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 17 scored 20 correct items for a correct percentage of 50% (HR). Student 17 did not take the second unit test due to being ill during the 2 week instruction period.

During the third unit test Student 17 scored 27 correct items overall for a correct percentage of 67.5% (RC/HR). Student 17 answered 12 hand raising instructed items correctly for a percentage of 60%. Student 17 answered 17 response card items correctly for a 85% accuracy rate.

During the fourth unit test Student 17 scored 22 correct items for a overall correct percentage of 55% (HR/RC). Student 17 answered 10 hand raising instructed items correctly for a correct percentage of 50%. Student 17 answered 12 response card items correctly for a correct percentage of 60%.

Student 17 scored a total of 71 items correct on all four unit tests for a correct overall percentage of 59%. Student 17 answered 42 hand raising instructed items correctly for all four unit tests for
Figure 77. Percentage of items answered by Student 17 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
a percentage of 53%. Student 17 scored 29 response card
instructed items correct for a percentage of 73%.

**Student 18.** Figure 78 shows Student 18's performance on
the 40 item bi-weekly unit tests and overall number of correct
items. During the first unit test Student 18 scored 21 correct items
for a correct percentage of 52.5% (HR). During the second unit test
Student 18 scored 24 correct items for a correct percentage of 60%
(RC).

During the third unit test Student 18 scored 22 correct items
overall for a correct percentage of 55% (RC/HR). Student 18
answered 6 hand raising instructed items correctly for a
percentage of 30%. Student 18 answered 16 response card items
correctly for a 80% accuracy rate.

During the fourth unit test Student 18 scored 20 correct items
for an overall correct percentage of 50% (HR/RC). Student 18
answered 5 hand raising instructed items correctly for a correct
percentage of 25%. Student 18 answered 15 response card items
correctly for a correct percentage of 75%.
Figure 78. Percentage of items answered by Student 18 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
Student 18 scored a total of 87 items correct on all four unit tests for a correct overall percentage of 54%. Student 18 answered 32 hand raising instructed items correctly for all four unit tests for a percentage of 40%. Student 18 scored 55 response card instructed items correct for a percentage of 69%.

Student 19. Figure 79 shows Student 19's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 19 scored 24 correct items for a correct percentage of 60% (HR). During the second unit test Student 19 scored 31 correct items for a correct percentage of 77.5% (RC).

During the third unit test Student 19 scored 28 correct items overall for a correct percentage of 70% (RC/HR). Student 19 answered 13 hand raising instructed items correctly for a percentage of 65%. Student 19 answered 15 response card items correctly for a 75% accuracy rate.

During the fourth unit test Student 19 scored 26 correct items for an overall correct percentage of 65% (HR/RC). Student 19 answered 9 hand raising instructed items correctly for a correct
Figure 79. Percentage of items answered by Student 19 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
percentage of 45%. Student 19 answered 17 response card items correctly for a correct percentage of 85%.

Student 19 scored a total of 109 items correct on all four unit tests for a correct overall percentage of 68%. Student 19 answered 46 hand raising instructed items correctly for all four unit tests for a percentage of 58%. Student 19 scored 63 response card instructed items correct for a percentage of 79%.

Student 20. Figure 80 shows Student 20's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 20 scored 9 correct items for a correct percentage of 22.5% (HR). During the second unit test Student 20 scored 20 correct items for a correct percentage of 50% (RC).

During the third unit test Student 20 scored 12 correct items overall for a correct percentage of 30% (RC/HR). Student 20 answered 5 hand raising instructed items correctly for a percentage of 25%. Student 20 answered 7 response card items correctly for a 35% accuracy rate.
Figure 80. Percentage of items answered by Student 20 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the fourth unit test Student 20 scored 14 correct items for a overall correct percentage of 35% (HR/RC). Student 20 answered 6 hand raising instructed items correctly for a correct percentage of 30%. Student 20 answered 8 response card items correctly for a correct percentage of 40%.

Student 20 scored a total of 55 items correct on all four unit tests for a correct overall percentage of 34%. Student 20 answered 20 hand raising instructed items correctly for all four unit tests for a percentage of 25%. Student 20 scored 35 response card instructed items correct for a percentage of 44%.

Student 21. Figure 81 shows Student 21's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 21 scored 27 correct items for a correct percentage of 67.5% (HR). During the second unit test Student 21 scored 37 correct items for a correct percentage of 92.5% (RC).

During the third unit test Student 21 scored 26 correct items overall for a correct percentage of 65% (RC/HR). Student 21 answered 13 hand raising instructed items correctly for a
Figure 81. Percentage of items answered by Student 21 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
percentage of 65%. Student 21 answered 14 response card items correctly for a 70% accuracy rate.

During the fourth unit test Student 21 scored 28 correct items for a overall correct percentage of 70% (HR/RC). Student 21 answered 12 hand raising instructed items correctly for a correct percentage of 60%. Student 21 answered 16 response card items correctly for a correct percentage of 80%.

Student 21 scored a total of 119 items correct on all four unit tests for a correct overall percentage of 74%. Student 21 answered 52 hand raising instructed items correctly for all four unit tests for a percentage of 65%. Student 21 scored 67 response card instructed items correct for a percentage of 84%.

Student 22. Figure 82 shows Student 22's performance on the 40 item bi-weekly unit tests and overall number of correct items. During the first unit test Student 22 scored 23 correct items for a correct percentage of 57.5% (HR). During the second unit test Student 22 scored 24 correct items for a correct percentage of 60% (HR).
Figure 82. Percentage of items answered by Student 22 correctly on unit tests during hand raising (HR) and response card (RC) conditions.
During the third unit test Student 22 scored 23 correct items overall for a correct percentage of 57.5% (RC/HR). Student 22 answered 5 hand raising instructed items correctly for a percentage of 25%. Student 22 answered 17 response card items correctly for a 85% accuracy rate.

Student 22 did take unit test 4 due to an extended illness at the end of the school year. Student 22 scored a total of 69 items correct on all four unit tests for a correct overall percentage of 57%. Student 22 answered 28 hand raising instructed items correctly for all four unit tests for a percentage of 47%. Student 22 scored 41 response card instructed items correct for a percentage of 68%.

**Group Rate**

Figure 83 shows the performance of the students on the 40 item bi-weekly unit tests and the overall rate of correct items. During the first unit test covering only items instructed during hand raising conditions the group correct percentage was 52%. During the second unit test covering items instructed only during response card conditions the group scored a correct percentage of 77%.
Figure 8.3. Mean percentage of items answered by all 22 students correctly on unit tests during hand raising (HR) and response card (RC) conditions.
Items for the third unit test were instructed during both hand raising and response card conditions. Unit test items 1-20 were instructed during response conditions and items 21-40 were instructed during hand raising conditions. The group scored an overall correct percentage of 61%. The group answered hand raising instructed items correctly at percentage of 50%. The group answered response card items correctly for at a 73% correct rate.

Items for the fourth unit test were instructed during both hand raising and response card conditions. Unit test items 1-20 were instructed during hand raising and items 21-40 were instructed during response card conditions. The group scored an overall correct percentage of 53%. The group answered hand raising instructed items correctly for at a correct percentage of 45%. The group answered response card items at a correct percentage of 61%.

The group scored items correct on all four unit tests for a correct overall percentage of 60.7%. The group scored 49% hand raising instructed items correct for all four unit tests. The group scored 70% response card instructed items correct for all four unit
Recall and Recognition

Student 1. Figure 84 shows the performance of Student 1 on recall and recognition items during hand raising and response card conditions. Student 1's performance on recall items instructed during hand raising conditions was 29 out of 40 scored correct across the four unit tests for a 72.5% accuracy rate. Student 1's performance on recognition items instructed during hand raising conditions was 31 out of 40 scored correct across the four unit tests for 77.5% accuracy rate.

Student 1's performance on recall items instructed during response card conditions was 37 out of 40 scored correct across the four unit tests for a 92.5% accuracy rate. Student 1's performance on recognition items instructed during response card conditions was 37 out of 40 scored correct across the four unit tests for 92.5% accuracy rate.

Student 2. Figure 85 shows the performance of Student 2 on recall and recognition items during hand raising and response card conditions. Student 2's performance on recall items instructed
Figure 8.4. Percentage of recall and recognition items answered correctly on unit tests by Student 1 during hand raising (HR) and response cards (RC) conditions.

Figure 8.5. Percentage of recall and recognition items answered correctly on unit tests by Student 2 during hand raising (HR) and response cards (RC) conditions.
during hand raising conditions was 23 out of 40 scored correct across the four unit tests for a 57.5% accuracy rate. Student 2's performance on recognition items instructed during hand raising conditions was 27 out of 40 scored correct across the four unit tests for 67.5% accuracy rate.

Student 2's performance on recall items instructed during response card conditions was 34 out of 40 scored correct across the four unit tests for a 85% accuracy rate. Student 2's performance on recognition items instructed during response card conditions was 38 out of 40 scored correct across the four unit tests for 95% accuracy rate.

**Student 3.** Figure 86 shows the performance of Student 3 on recall and recognition items during hand raising and response card conditions. Student 3's performance on recall items instructed during hand raising conditions was 3 out of 40 scored correct across the four unit tests for a 7.5% accuracy rate. Student 3's performance on recognition items instructed during hand raising conditions was 14 out of 40 scored correct across the four unit tests for 35% accuracy rate.
Figure 86. Percentage of recall and recognition items answered correctly on unit tests by Student 3 during hand raising (HR) and response cards (RC) conditions.
Student 3's performance on recall items instructed during response card conditions was 16 out of 40 scored correct across the four unit tests for a 40% accuracy rate. Student 3's performance on recognition items instructed during response card conditions was 25 out of 40 scored correct across the four unit tests for 62.5% accuracy rate.

Student 4. Figure 87 shows the performance of Student 4 on recall and recognition items during hand raising and response card conditions. Student 4's performance on recall items instructed during hand raising conditions was 4 out of 40 scored correct across the four unit tests for a 10% accuracy rate. Student 4's performance on recognition items instructed during hand raising conditions was 18 out of 40 scored correct across the four unit tests for 45% accuracy rate.

Student 4's performance on recall items instructed during response card conditions was 16 out of 40 scored correct across the four unit tests for a 40% accuracy rate. Student 4's performance on recognition items instructed during response card conditions was 17 out of 40 scored correct across the four unit tests for 42.5%
Figure 87. Percentage of recall and recognition items answered correctly on unit tests by Student 4 during hand raising (HR) and response cards (RC) conditions.
accuracy rate.

**Student 5.** Figure 88 shows the performance of Student 5 on recall and recognition items during hand raising and response card conditions. Student 5's performance on recall items instructed during hand raising conditions was 30 out of 40 scored correct across the four unit tests for a 75% accuracy rate. Student 5's performance on recognition items instructed during hand raising conditions was 34 out of 40 scored correct across the four unit tests for 85% accuracy rate.

Student 5's performance on recall items instructed during response card conditions was 39 out of 40 scored correct across the four unit tests for a 97.5% accuracy rate. Student 5's performance on recognition items instructed during response card conditions was 37 out of 40 scored correct across the four unit tests for 92.5% accuracy rate.

**Student 6.** Figure 89 shows the performance of Student 6 on recall and recognition items during hand raising and response card conditions. Student 6's performance on recall items instructed during hand raising conditions was 10 out of 40 scored correct
Figure 8.8. Percentage of recall and recognition items answered correctly on unit tests by Student 5 during hand raising (HR) and response cards (RC) conditions.

Figure 8.9. Percentage of recall and recognition items answered correctly on unit tests by Student 6 during hand raising (HR) and response cards (RC) conditions.
across the four unit tests for a 25% accuracy rate. Student 6's performance on recognition items instructed during hand raising conditions was 21 out of 40 scored correct across the four unit tests for 52.5% accuracy rate.

Student 6's performance on recall items instructed during response card conditions was 22 out of 40 scored correct across the four unit tests for a 55% accuracy rate. Student 6's performance on recognition items instructed during response card conditions was 27 out of 40 scored correct across the four unit tests for 67.5% accuracy rate.

**Student 7.** Figure 90 shows the performance of Student 7 on recall and recognition items during hand raising and response card conditions. Student 7's performance on recall items instructed during hand raising conditions was 0 out of 40 scored correct across the four unit tests for a 0% accuracy rate. Student 7's performance on recognition items instructed during hand raising conditions was 5 out of 40 scored correct across the four unit tests for 12.5% accuracy rate.
Figure 90. Percentage of recall and recognition items answered correctly on unit tests by Student 7 during hand raising (HR) and response cards (RC) conditions.
Student 7's performance on recall items instructed during response card conditions was 7 out of 40 scored correct across the four unit tests for a 17.5% accuracy rate. Student 7's performance on recognition items instructed during response card conditions was 19 out of 40 scored correct across the four unit tests for 47.5% accuracy rate.

Student 8. Figure 91 shows the performance of Student 8 on recall and recognition items during hand raising and response card conditions. Student 8's performance on recall items instructed during hand raising conditions was 25 out of 40 scored correct across the four unit tests for a 62.5% accuracy rate. Student 8's performance on recognition items instructed during hand raising conditions was 32 out of 40 scored correct across the four unit tests for 80% accuracy rate.

Student 8's performance on recall items instructed during response card conditions was 34 out of 40 scored correct across the four unit tests for a 85% accuracy rate. Student 8's performance on recognition items instructed during response card conditions was 31 out of 40 scored correct across the four unit tests for 77.5%
Figure 91. Percentage of recall and recognition items answered correctly on unit tests by Student 8 during hand raising (HR) and response cards (RC) conditions.
Student 9. Figure 92 shows the performance of Student 9 on recall and recognition items during hand raising and response card conditions. Student 9's performance on recall items instructed during hand raising conditions was 7 out of 40 scored correct across the four unit tests for a 17.5% accuracy rate. Student 9's performance on recognition items instructed during hand raising conditions was 16 out of 40 scored correct across the four unit tests for 40% accuracy rate.

Student 9's performance on recall items instructed during response card conditions was 14 out of 35 scored correct across the four unit tests for a 35% accuracy rate. Student 9's performance on recognition items instructed during response card conditions was 26 out of 40 scored correct across the four unit tests for 65% accuracy rate.

Student 10. Figure 93 shows the performance of Student 10 on recall and recognition items during hand raising and response card conditions. Student 10's performance on recall items instructed during hand raising conditions was 10 out of 40 scored
Figure 9.2. Percentage of recall and recognition items answered correctly on unit tests by Student 9 during hand raising (HR) and response cards (RC) conditions.

Figure 9.3. Percentage of recall and recognition items answered correctly on unit tests by Student 10 during hand raising (HR) and response cards (RC) conditions.
correct across the four unit tests for a 25% accuracy rate. Student 10's performance on recognition items instructed during hand raising conditions was 12 out of 40 scored correct across the four unit tests for 30% accuracy rate.

Student 10's performance on recall items instructed during response card conditions was 34 out of 40 scored correct across the four unit tests for a 85% accuracy rate. Student 10's performance on recognition items instructed during response card conditions was 36 out of 40 scored correct across the four unit tests for 90% accuracy rate.

Student 11. Figure 94 shows the performance of Student 11 on recall and recognition items during hand raising and response card conditions. Student 11's performance on recall items instructed during hand raising conditions was 29 out of 40 scored correct across the four unit tests for a 72.5% accuracy rate. Student 11's performance on recognition items instructed during hand raising conditions was 36 out of 40 scored correct across the four unit tests for 90% accuracy rate.
Figure 94. Percentage of recall and recognition items answered correctly on unit tests by Student 11 during hand raising (HR) and response cards (RC) conditions.
Student 11's performance on recall items instructed during response card conditions was 39 out of 40 scored correct across the four unit tests for a 97.5% accuracy rate. Student 11's performance on recognition items instructed during response card conditions was 38 out of 40 scored correct across the four unit tests for 95% accuracy rate.

**Student 12.** Figure 95 shows the performance of Student 12 on recall and recognition items during hand raising and response card conditions. Student 12's performance on recall items instructed during hand raising conditions was 24 out of 40 scored correct across the four unit tests for a 60% accuracy rate. Student 12's performance on recognition items instructed during hand raising conditions was 31 out of 40 scored correct across the four unit tests for 71% accuracy rate.

Student 12's performance on recall items instructed during response card conditions was 30 out of 40 scored correct across the four unit tests for a 75% accuracy rate. Student 12's performance on recognition items instructed during response card conditions was 33 out of 40 scored correct across the four unit tests for 82.5%
Figure 9.5. Percentage of recall and recognition items answered correctly on unit tests by Student 12 during hand raising (HR) and response cards (RC) conditions.
accuracy rate.

**Student 13.** Figure 96 shows the performance of Student 13 on recall and recognition items during hand raising and response card conditions. Student 13’s performance on recall items instructed during hand raising conditions was 26 out of 40 scored correct across the four unit tests for a 65% accuracy rate. Student 13’s performance on recognition items instructed during hand raising conditions was 31 out of 40 scored correct across the four unit tests for 71% accuracy rate.

Student 13’s performance on recall items instructed during response card conditions was 39 out of 40 scored correct across the four unit tests for a 97.5% accuracy rate. Student 13’s performance on recognition items instructed during response card conditions was 33 out of 40 scored correct across the four unit tests for 73% accuracy rate.

**Student 14.** Figure 97 shows the performance of Student 14 on recall and recognition items during hand raising and response card conditions. Student 14’s performance on recall items instructed during hand raising conditions was 8 out of 40 scored
Figure 96. Percentage of recall and recognition items answered correctly on unit tests by Student 13 during hand raising (HR) and response cards (RC) conditions.

Figure 97. Percentage of recall and recognition items answered correctly on unit tests by Student 14 during hand raising (HR) and response cards (RC) conditions.
correct across the four unit tests for a 20% accuracy rate. Student 14's performance on recognition items instructed during hand raising conditions was 24 out of 40 scored correct across the four unit tests for 60% accuracy rate.

Student 14's performance on recall items instructed during response card conditions was 21 out of 40 scored correct across the four unit tests for a 52.5% accuracy rate. Student 14's performance on recognition items instructed during response card conditions was 29 out of 40 scored correct across the four unit tests for 72.5% accuracy rate.

Student 15. Figure 98 shows the performance of Student 15 on recall and recognition items during hand raising and response card conditions. Student 15's performance on recall items instructed during hand raising conditions was 11 out of 40 scored correct across the four unit tests for a 27.5% accuracy rate. Student 15's performance on recognition items instructed during hand raising conditions was 25 out of 40 scored correct across the four unit tests for 62.5% accuracy rate.
Figure 98. Percentage of recall and recognition items answered correctly on unit tests by Student 15 during hand raising (HR) and response cards (RC) conditions.
Student 15's performance on recall items instructed during response card conditions was 25 out of 40 scored correct across the four unit tests for a 62.5% accuracy rate. Student 15's performance on recognition items instructed during response card conditions was 30 out of 40 scored correct across the four unit tests for 70% accuracy rate.

Student 16. Figure 99 shows the performance of Student 16 on recall and recognition items during hand raising and response card conditions. Student 16's performance on recall items instructed during hand raising conditions was 27 out of 40 scored correct across the four unit tests for a 67.5% accuracy rate. Student 16's performance on recognition items instructed during hand raising conditions was 36 out of 40 scored correct across the four unit tests for 90% accuracy rate. Student 16's performance on recall items instructed during response card conditions was 39 out of 40 scored correct across the four unit tests for a 97.5% accuracy rate. Student 16's performance on recognition items instructed during response card conditions was 37 out of 40 scored correct across the four unit tests for 92.5% accuracy rate.
Figure 99. Percentage of recall and recognition items answered correctly on unit tests by Student 16 during hand raising (HR) and response cards (RC) conditions.
accuracy rate.

**Student 17.** Figure 100 shows the performance of Student 17 on recall and recognition items during hand raising and response card conditions. Student 17's performance on recall items instructed during hand raising conditions was 13 out of 40 scored correct across the four unit tests for a 53% accuracy rate. Student 17's performance on recognition items instructed during hand raising conditions was 31 out of 40 scored correct across the four unit tests for 77.5% accuracy rate.

Student 17's performance on recall items instructed during response card conditions was 11 out of 20 scored correct across the four unit tests for a 55% accuracy rate (Student 17 did not take the second unit test). Student 17's performance on recognition items instructed during response card conditions was 16 out of 20 scored correct across the four unit tests for 80% accuracy rate.

**Student 18.** Figure 101 shows the performance of Student 18 on recall and recognition items during hand raising and response card conditions. Student 18's performance on recall items instructed during hand raising conditions was 11 out of 40 scored correct
**Figure 100.** Percentage of recall and recognition items answered correctly on unit tests by Student 17 during hand raising (HR) and response cards (RC) conditions.

**Figure 101.** Percentage of recall and recognition items answered correctly on unit tests by Student 18 during hand raising (HR) and response cards (RC) conditions.
across the four unit tests for a 27.5% accuracy rate. Student 18’s performance on recognition items instructed during hand raising conditions was 21 out of 40 scored correct across the four unit tests for 52.5% accuracy rate.

Student 18’s performance on recall items instructed during response card conditions was 24 out of 40 scored correct across the four unit tests for a 60% accuracy rate. Student 18’s performance on recognition items instructed during response card conditions was 31 out of 40 scored correct across the four unit tests for 77.5% accuracy rate.

Student 19. Figure 102 shows the performance of Student 19 on recall and recognition items during hand raising and response card conditions. Student 19’s performance on recall items instructed during hand raising conditions was 17 out of 40 scored correct across the four unit tests for a 42.5% accuracy rate. Student 19’s performance on recognition items instructed during hand raising conditions was 29 out of 40 scored correct across the four unit tests for 69% accuracy rate.
Figure 10.2. Percentage of recall and recognition items answered correctly on unit tests by Student 19 during hand raising (HR) and response cards (RC) conditions.
Student 19's performance on recall items instructed during response card conditions was 30 out of 40 scored correct across the four unit tests for a 75% accuracy rate. Student 19's performance on recognition items instructed during response card conditions was 33 out of 40 scored correct across the four unit tests for 82.5% accuracy rate.

**Student 20.** Figure 103 shows the performance of Student 20 on recall and recognition items during hand raising and response card conditions. Student 20's performance on recall items instructed during hand raising conditions was 2 out of 40 scored correct across the four unit tests for a 5% accuracy rate. Student 20's performance on recognition items instructed during hand raising conditions was 18 out of 40 scored correct across the four unit tests for 45% accuracy rate.

Student 20's performance on recall items instructed during response card conditions was 14 out of 40 scored correct across the four unit tests for a 35% accuracy rate. Student 20's performance on recognition items instructed during response card conditions was 21 out of 40 scored correct across the four unit tests for 61%
Figure 10.3. Percentage of recall and recognition items answered correctly on unit tests by Student 20 during hand raising (HR) and response cards (RC) conditions.
accuracy rate.

Student 21. Figure 104 shows the performance of Student 21 on recall and recognition items during hand raising and response card conditions. Student 21's performance on recall items instructed during hand raising conditions was 27 out of 40 scored correct across the four unit tests for a 67.5% accuracy rate. Student 21's performance on recognition items instructed during hand raising conditions was 25 out of 40 scored correct across the four unit tests for 65% accuracy rate.

Student 21's performance on recall items instructed during response card conditions was 33 out of 40 scored correct across the four unit tests for a 73% accuracy rate. Student 21's performance on recognition items instructed during response card conditions was 34 out of 40 scored correct across the four unit tests for 74% accuracy rate.

Student 22. Figure 105 shows the performance of Student 22 on recall and recognition items during hand raising and response card conditions. Student 22's performance on recall items instructed during hand raising conditions was 10 out of 30 scored
Figure 104. Percentage of recall and recognition items answered correctly on unit tests by Student 21 during hand raising (HR) and response cards (RC) conditions.

Figure 105. Percentage of recall and recognition items answered correctly on unit tests by Student 22 during hand raising (HR) and response cards (RC) conditions.
correct across the four unit tests for a 33% accuracy rate (Student 22 did not take unit test 4). Student 22's performance on recognition items instructed during hand raising conditions was 18 out of 30 scored correct across the four unit tests for 60% accuracy rate. Student 22's performance on recall items instructed during response card conditions was 16 out of 30 scored correct across the four unit tests for a 53% accuracy rate. Student 22's performance on recognition items instructed during response card conditions was 25 out of 30 scored correct across the four unit tests for 83% accuracy rate.

**Group Results**

Figure 106 shows the performance of the group on recall and recognition items during hand raising and response card conditions. The group scored 39% correct on recall items instructed during hand raising conditions over the four unit tests. The group scored 60% correct on recognition items instructed during hand raising conditions.

The group scored 65% correct on recall items instructed during response card conditions. The group scored 74% recognition
Figure 106. Mean percentage of recall and recognition items answered correctly on unit tests by all 22 students during hand raising (HR) and response cards (RC) conditions.
Table 7

Group mean rate and percentage of items correct on the unit tests on recall and recognition items across hand raising (HR) and response card (RC) conditions.

<table>
<thead>
<tr>
<th></th>
<th>RECALL</th>
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<th>RECOGNITION</th>
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</thead>
<tbody>
<tr>
<td>HR</td>
<td>15.7/39%</td>
<td></td>
<td>24.3/60%</td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>26/65%</td>
<td></td>
<td>29/74%</td>
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</table>
items instructed during response card conditions (see Table 7).

**Student Status**

The performance of at risk and not at risk students are examined in regards to their quiz and unit test scores. The status of each student was determined by performance on standardized tests, academic grades, and teacher evaluation. Students 1, 2, 5, 8, 10, 11, 12, 13, 15, 16, 18, 19, and 21 were determined to be not at risk academically. Students 3, 4, 6, 7, 9, 14, 17, 20, and 22 were determined to be academically at risk of failure or special education placement.

**Daily Quiz**

Table 5 shows the performance of at risk and not at risk students on the 16-item daily quizzes across experimental phases. During the first hand raising phase the mean number of correct items for not at risk students was 11.3. The mean score for not at risk students during the second hand raising phase was 10. The mean for both hand raising phases was 9.8.

During the first hand raising phase the mean number of correct items was 7.4 for at risk students. The mean score for at
risk students during the second hand raising phase was 5.4. The mean for both hand raising phases was 6.1.

During the first response card phase the mean number of correct items for not at risk students was 12.9. The mean score for not at risk students during the second response card phase was 13. The mean for both response card phases was 13.

During the first response card phase the mean number of correct items for at risk students was 8.1. The mean correct score for at risk students during the second response card phase was 8.25. The mean for both response card phases was 8.5 (see Table 5).

Recall and Recognition

Table 6 shows the performance of at risk and not at risk students on the daily quiz recall and recognition items.

Not At risk students. During the first hand raising phase the mean score for correct recall items for not at risk students was 4.8. The mean score of correct recognition items during the first hand raising phase for not at risk students was 6.4.
During the second hand raising phase the mean score for correct recall items for not at risk students was 4.2. The mean score of correct recognition items during the second hand raising phase for not at risk students was 5.8. The mean for correct recall items for both hand raising phases for not at risk students was 4.3. The mean for correct recognition items for both hand raising phases for not at risk students was 6.

During the first response card phase the mean score for correct recall items for not at risk students was 6.1. The mean score of correct recognition items during the first response card phase for not at risk students was 6.6.

During the second response card phase the mean score for correct recall items for not at risk students was 6.2. The mean score of correct recognition items during the second response card phase for not at risk students was 6.8. The mean score of correct recall items for both hand raising phases for not at risk students was 6.5. The mean for correct recognition items for both hand raising phases for not at risk students was 6.7.
At Risk Students. During the first hand raising phase the mean score for correct recall items for at risk students was 2.2. The mean score of correct recognition items during the first hand raising phase for at risk students was 4.5.

During the second hand raising phase the mean score for correct recall items for at risk students was 1.6. The mean score of correct recognition items during the first hand raising phase for at risk students was 4.

During the first response card phase the mean score for correct recall items for at risk students was 3.6. The mean score of correct recognition items during the first response card phase for at risk students was 5.1.

During the second response card phase the mean score for correct recall items for at risk students was 2.4. The mean score of correct recognition items during the second response card phase for at risk students was 5.8. The mean score of correct recall items for both hand raising phases for at risk students was 2.9. The mean score for correct recognition items for both hand raising phases for not at risk students was 5.6 (see Table 6).
Student's Preferences and Opinions

Sixteen of the 22 students said that they liked the write-on response cards better than when hand raising was the response mode. Six students liked hand raising better as the response mode.

In response the question which response mode helped them learn better, 19 said write-on response cards. Only three students felt that hand raising helped them more.

Twenty of the students felt that the write-on response cards helped them to get the best grades. Two students felt that hand raising helped them get better grades (see Table 8).

Many students stated that they did not like hand raising because they did not get called upon enough to answer questions. They also disliked holding their hands up for a "long time". The teacher seemed to call on some students more than others. A reason given for liking hand raising was that when called upon they were the only one allowed to answer a question.

Some of the reasons given for liking write-on response cards were that everyone had a chance to answer all the questions without having to wait to be called upon. Many students
Table 8

Student preferences for responding to teacher questions.

<table>
<thead>
<tr>
<th></th>
<th>Hand raising</th>
<th>Response cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorite</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Helped more</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>Best grades</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>
mentioned using he response cards was fun. Many students stated
that they liked the two minutes at the end of the lesson to draw.
One aspect of the write-on response card students did not like was
having to erase after each answer some felt that the erasing
process was messy.

Many students reported that they liked the way the lessons
were presented and enjoyed the science demonstrations.

**Interobserver Agreement Results**

Table 9 shows the interval-by interval agreement for the
dependent variables during instruction of student response
attempt rate, total response rate, and correct response rate for the
seven target students by experimental phase.

For the first hand raising phase the mean interobserver
agreement for response attempt rate was 98% with a range of 92-
100% agreement across five students. The mean interobserver
agreement for total response rate was 99% with a range of 95
-100%. The mean interobserver agreement for correct response
rate was 98% with a range of 92-100%. 
Table 9

Interval-by Interval Dependent Variable Agreement Score for Response Attempts.

<table>
<thead>
<tr>
<th>Total response, and Correct Response by Target Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Raising 1</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Students</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>Group Mean</td>
</tr>
</tbody>
</table>
For the second hand raising phase the mean interobserver agreement for response attempt rate was 90% with a range of 82-100% agreement across seven students. The mean interobserver agreement for total response rate was 98% with a range of 94-100%. The mean interobserver agreement for correct response rate was 98% with a range of 94-100%.

For the first response card phase the mean interobserver agreement for total response rate was 96% with a range of 94-100% across seven students. The mean interobserver agreement for correct response rate was 93% with a range of 82-100%.

Interobserver agreement on total response rate for the second response card phase ranged from 92-100% with a mean of 96%. The mean interobserver agreement for correct response rate was 96% with a range of 92-100%.

Reliability Results

Reliability results on the daily quiz scores for all the students along with the group mean and range of reliability, as determined by a true value, can be seen in Table 10. The mean reliability for all four phases for the class was 97% with a range of 94-100%.
Table 10

Reliability Percentages on Daily Quiz Scores by Experimental Phase.

<table>
<thead>
<tr>
<th>Student</th>
<th>HR 1</th>
<th>RC 1</th>
<th>HR 2</th>
<th>RC 2</th>
<th>Mean</th>
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<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>100</td>
<td>94</td>
<td>88</td>
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<tr>
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<td>100</td>
<td>96</td>
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</tbody>
</table>

Group Mean: 97
Group Range: 94-100
Reliability results on the unit test scores for all the students along with the group mean and range of agreement can be seen in Table 11. The mean reliability results for all four phases for the class was 98.4% with a range of 95-100% agreement.
Table 11

Reliability Percentages on Unit Test Scores.

<table>
<thead>
<tr>
<th>Students</th>
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<th>Unit Test 4</th>
<th>Mean</th>
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</thead>
<tbody>
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<td>95</td>
<td>96.5</td>
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<td>97.5</td>
</tr>
<tr>
<td>22</td>
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<td>-</td>
</tr>
</tbody>
</table>

Group Mean 98.4

Group Range 95 - 100%
CHAPTER V

DISCUSSION

This chapter discusses the results of the study comparing hand raising and write-on response cards during large-group science instruction. The study was conducted to examine the use of response cards on the academic achievement of at risk and non at risk 5th grade elementary children. The effects of the two types of student responding, hand raising and write-on response cards, on the rate and accuracy of responses were analyzed. The study also looked at the relationship between the type of student responding during instruction and student performance on daily quizzes and bi-weekly unit tests. This chapter discusses the results relative to the nine research questions posed at the study's outset. Also included in this chapter are limitations of the study, implications for classroom practice, and suggestions for future research.
Research Question One

What method of student responding, hand raising or response cards, produces the highest frequency of active student response during instruction? Does the active student response rate of at risk students vary as a function of the student response method used?

The seven target students averaged .09 responses per minute during the combined hand raising phases. During the two response card phases, the same seven students responded at a rate of .72 responses per minute. The group average response rate during response card sessions was eight times the response rate during the hand raising phases. Each target student averaged a total of 2.25 responses per minute in a 25-minute session when hand raising was the response mode (.09 \times 25). During response card conditions the average rate of response was 18 (72 \times 25) during a 25-minute session.

In a 25-minute using hand raising session an average of 56 individual learning trials was conducted (2.25 learning trials per student \times 25 minutes). By comparison, the teacher managed an average of 450 learning trials per 25-minute session when
response cards were used (18 learning trials per student x 25 students).

The target students attempted to respond during hand raising sessions at a rate much higher than .09 responses per minute. However, despite raising their hands at an average rate of .49 per minute, individual students were generally called upon only once or twice during a session. Those times when an individual student was called on more than twice usually reflected that many of the student's classmates had ceased raising their hands to the teacher's questions.

This one-at-a-time form of responding provided limited opportunities for students to respond and appeared frustrating for some students. Some students showed their frustration by not raising their hands when questions were asked, putting their heads on their desks during the lesson, and/or calling out answers without being called upon by the teacher. Students often complained about having their hand raised but not being called upon. Narayan (1988) found similar student reactions in a study analyzing the effects of hand raising and response cards during
large group social studies instruction. During hand raising phases there were actually a higher rate of teacher presented opportunities to respond, but because of the one-at-time mode of responding, a much lower rate of student response was obtained.

Each at risk student increased his response rate during response card phases as compared with the hand raising phases. Student 7, an at risk student, who made no responses during all 13 hand raising sessions, responded at a rate of .22 responses per minute during the response card phases for a total of 71 responses in the 13 responses card sessions. While Student 7's response rate of .22 was the lowest of all the target students during the response card condition, it still represents a significant change from a rate of 0.

The average rate of active responses for the four at risk target students during the second hand raising phase was .04 responses per minute, compared to an average rate of .53 responses per minute during the second response card phase (data were not collected on two of the at risk students during the first hand raising
This difference is an increase of .49 responses per minute for the at risk students in the response card phase (see Table 3). During the second response card phase the at risk students rate of responding of .53 responses per minute was 13 times higher than their response rate during the second hand raising phase.

When the average rate of responding for all seven target students is compared across experimental phases, similar results are evident. During the two hand raising phases the average rate of responding was .09 response per minute. However, during the two response card phases the average rate of responses per minute was .72 (see Table 3). Similar increases in response rate can be seen for each individual student across conditions. The use of response cards greatly increased the rate of active student response during whole-class science instruction for both the at risk and non at risk students in this study.

Research Question Two

What method of student responding, hand raising or response cards, produces the highest accuracy responses of students during instruction?
As a group the seven target students correctly responded to teacher questions at a rate of .07 during the combined hand raising phases. Their rate of correct responses per minute was .59 during the combined response card phases. This increase in accurate responding is more than eight times the correct rate under hand raising conditions. The four at risk target students rate of correct responses was .03 during the second hand raising phase and .32 during the second response card phase. This difference represents a correct rate during response cards over 10 times that during hand raising (see Table 3).

Students seemed excited to get the answer correct during response card sessions. They showed their excitement by smiles and verbal statements such as: "I got it right", "Yea!", or "Yes!". During hand raising sessions only one student had the opportunity to respond after each teacher-posed question. Therefore, only one student could receive positive feedback for giving the correct response. The student who received positive feedback during hand raising conditions was pleased, but the other students often seemed indifferent or jealous. Sometimes the not called upon students
would make negative comments such as: "That was easy," or "I don't see what's so good about that."

**Research Question Three**

**What is the rate per minute of teacher presented learning trials with each method of student responding?**

During the combined hand raising phases the mean teacher presentation rate was 1.54 learning trials per minute. The combined mean teacher presentation rate for learning trials across both hand raising phases was .99 per minute (see Table 2). However, as the results on student response rates clearly show, the apparent advantage of the hand raising over response cards method in terms of a higher teacher presentation rate is greatly outweighed by the huge difference in active student involvement. The hand raising phases produced the highest rate of teacher presented learning trials. Because the teacher had to wait for students to write on their response card and then erase them prior to the next trial, a lower rate during response card sessions was obtained. Narayan (1988) found similar results when she compared hand raising and write-on response card student
responding.

**Research Question Four**

What method of student responding, hand raising or response cards, produces the highest scores by 5th grade students on science quizzes administered the next day after instruction? Specifically, do the quiz scores of at risk students vary as function of the student response method used?

Students' scores on daily quizzes given on the session following instruction were used as one indicator of academic achievement. Quiz scores for most of the students displayed a great deal of variability throughout the study. Quiz scores for only six students (Students 1, 10, 12, 14, 19, and 22) show that response cards had a replicable effect on quiz scores. For these six students not only did the quiz scores improve from the first hand raising phase to the first response card phase, but the effect was replicated in the second response card phase.

Response cards had either a weak or non-replicated effect on the quiz scores of all other students in the study. Because there is so much overlap from phase to phase in the number of correct
items that definitive statements can not be made. However, no average student's quiz score performance deteriorated during either response card phases, from its level during the previous hand raising phases. The increased instability in the classroom during the second response card phase may have been responsible, at least in part, for the effect not being replicated. The students' regular classroom teacher was frequently absent during this phase and there were four different substitute teachers compounded with the fact that this was the end of the school year. Another factor possibly causing the wide variability in individual students' in quiz scores was the varying level of difficulty of the content presented during each session.

Finally, the students in this class generally did not seem to have a great deal of teacher imposed instruction structure, prior to the beginning of this project. Most of the instruction, before the study, appeared to occur through seatwork with very little direct teacher instruction. Each of the students seemed to respond differently to the instructional structure of this project with most students seeming to benefit from the systematic instruction and
feedback on their performance. All students were anxious to see their daily quiz scores and seemed pleased read the positive comments written by the experimenter on the quiz papers. The same student reaction was seen when unit test were returned. There were also students who would approach the experimenter before and after sessions to discuss different facts that were presented which interested them. During the initial sessions of this study positive comments about the class by the experimenter were met with student comments such as: "He is just psyching us.\textquotedblright, or "He just wants us to feel good". These types of comments to positive statements about the class seemed to decrease as the study progressed.

While there was frequently not a clear graphic functional relationship between the type of student responding and quiz scores there was some interesting results on the daily quizzes. The mean scores for each student improved from both hand raising phases to both response card phases (see Table 8). As a group the mean score for both hand raising phases was 8.8, for an overall failing grade of 55%. The group mean for both response card
phases was 11.15 or a "C-" (70%).

Students considered not at risk had a combined mean score of 9.8 "F" during hand raising condition while their mean quiz score was 13 correct items or a "B-" when response cards were used. At risk students had a mean score of correct items of 6.1 during hand raising conditions and 8.5 during response card conditions.

Mean quiz scores for non at risk Students 10, 15, 18, 19, and 21 equaled a failing grade when hand raising was the mode of student response. The quiz scores of each of these students, however, was high enough during the combined response card phases to equal a passing grade, with Student 10 making the greatest improvement going from a "F" to a "B". Under response card conditions all not at risk students scored a mean score of at least 10, the minimum for passing (see Table 8).

During hand raising conditions all of the at risk students had a mean score lower than 10 correct items, the minimum score for a passing grade. However, during response card conditions three of the nine at risk students improved their mean score to more than 10 correct items. Each of the nine at risk students improved his
mean score during response card conditions in comparison to hand raising conditions. The mean score for at risk students during hand raising conditions was 6.1 correct items or a "F". During responses card phases the mean score improved, but still was only 8.25 correct items or a "F".

Overall, during the combined hand raising phases 14 of the 22 students were failing and no student was scoring high enough to earn the grade of "A". During the combined response card conditions only 6 students failed to earn the equivalent of a passing grade (an average score of at least 10 items correct) and Students 2, 11, and 16 scored well enough to earn a grade of "A". These results support the findings in other research that increased opportunity to respond correlates with positive gains in the academic achievement of learners (Greenwood et al., 1984).

Narayan (1988) also found that increased opportunity to respond during large group instruction is an important factor in increasing students academic achievement. She compared the effects of hand raising, write-on response cards, and pre-printed response cards on the academic achievement of 4th grade students.
in social studies during large group instruction. Both pre-printed response cards and write-on response cards proved superior to hand raising in improving student achievement on daily quizzes.

In a related study, Pratton and Hales (1986) compared "active participation" method with "non-active participation" method. Two groups of 5th grade students were taught the same lesson, each group using one of the two different methods. Students in the participation method would hold up their fingers corresponding to their choice for the solution to the math problem. For the students in the non-active group the teacher worked problems on the board. Results indicated students in the active participation group performed better on the posttest than the students in the non active group.

Courson (1989) in a study examining the effects of guided notes and students' own notes in social studies found that both academically at risk and learning disabled students increased their performance on quizzes when active student responding was increased using guided notes. Courson's study which took place in a suburban middle school demonstrated the effectiveness of active
student responding and improving the low functioning student performance from one of failure to one of passing. One student went from a failing grade on quizzes to a score of "A". All 19 of Courson’s subjects improved their quiz scores, with only three of the previously 14 failing students scoring below the passing level under guided notes conditions.

**Research Question Five**

Is there a relationship between the type of quiz question (recall or recognition) students answer correctly on the daily quiz and the mode of student responding used during instruction?

The data obtained in this study do not show a clear relationship between students’ performance on different types of quiz/unit test questions (recall or recognition) and the mode of student responding used during instruction. There was a trend of increased correct responses to both recall and recognition correct items during response card phases. The data did indicate a more even distribution of correct responses to recall and recognition items during the response card phases. The lack of a more definitive relationship between the type of question and student
mode of responding may have been hampered by the variability between quizzes. Also, the students' previous exposure to various topics covered in this study could have caused this lack of a clear replicable relationship. Both at risk and not at risk students had a great deal of variability in their respective data, so no definitive statements can be made about either group except for the fact the average scores for each student improved under response card conditions as compared to hand raising conditions.

**Research Question Six**

*Is there a difference in the number of items students answer correctly on unit tests, at the end of two week instruction period, as function of the mode of student responding?*

The unit tests consisted of 40-items each item having previously been used on one of the daily quizzes during the prior two weeks period. The unit tests were given every two weeks during the course of this study. The first unit test consisted of only items instructed during hand raising conditions. The second unit test had only items instructed during response card conditions. Unit tests three and four each had an equal number of hand raising
instructed items and response card instructed items.

While the results of the unit tests have to be tempered with the fact that there were only four unit tests given in this project limiting the conclusions that can be drawn the result are very interesting. The results indicated a strong effect between the type of student responding during instruction and the student achievement on the unit tests. The group mean on correct items on each unit test for items instructed during hand raising conditions was 49% at failing rate. The group mean for all items instructed during response card conditions was 70% correct items or a "C". On unit test four Student 14 showed a significantly higher number of correct items instructed during hand raising than items instructed during response card conditions. The overall number of correct items for all four tests for Student 14 was still higher for items instructed during response card conditions. Student 14 was one of the four (Students 6, 17, and 22) at risk students who had a overall failing score during hand raising conditions and a passing score on items instructed during the responses card phases. At risk Students 3, 4, 6, and 7 all performed more poorly than usual on
unit test four which may have been reflective of their general attitude toward school at that point of the school year.

Courson (1989) found during her study using guided notes with at risk students that each of the students performed better on maintenance tests when guided notes had been used during instruction. Students had a mean score of 33% on the bi-weekly test when they used their own notes as compared with 70% when guided notes were used.

In another study Narayan (1988) examined the effects of pre-printed response cards and hand raising on the student performance on review tests. Narayan found that there was a 10% or more improvement on student scores on items reviewed with response cards for 11 out of 18 students. Only 2 students scored 10% or higher on items reviewed using hand raising.

The results of the studies conducted to date seem to indicate that there are some maintenance benefits for active student responding as contrasted to the traditional more passive student method of responding.
Research Question Seven

Is there a relationship between the type of question the student is able to answer correctly (recall or recognition) on unit test and the mode of student responding in effect during content instruction.

The results indicate that students are able to respond correctly more often to recognition questions more so than recall questions. However, the most important factor seems to be not the type of question but whether the item was instructed during response card conditions or hand raising conditions. The items instructed during response card conditions were answered by students at a higher accuracy rate than items instructed during hand raising phases. The group answered 39% of the recall items instructed during hand raising conditions correctly. The group answered 65% of the recall items correctly that had been instructed during response card conditions. The group percentage of correct recognition items on information instructed during hand raising conditions was 60%. Recognition items were answered correctly at an average of 74% on information instructed during response card conditions. Response cards improved the frequency of correct
items for both types of questions. There was a dramatic increase of 26% correct recall items when response cards were used for instruction indicating that there is a relationship between the type of question and mode of student responding. There was a smaller increase in correct recognition items across experimental conditions with a 14% improvement of response card instructed items over hand raising instructed items.

Research Question Eight

Is the most effective mode of student responding the same for at risk students as it is for the not at risk students?

The results indicate that both not at risk and at risk students benefit from the use of response cards in instruction. There was an increase in active student responding, improved average scores on quizzes, and more correctly answered items during response card phases for all students in this study. This is a similar result to Narayan (1988) findings. Also, Courson (1989) and Greenwood et al. (1984) in their respective studies involving active student responding and at risk student achievement found that by increasing the active student responding for both at risk and non at
risk students the academic performance improved for each student.

Research Question Nine

When asked their opinions after the study, which methods of responding will the students prefer, hand raising or response cards?

Sixteen of the 22 students preferred response cards as their mode of student responding. Nineteen students felt that response cards produced better quiz scores for them. Students said they liked the lessons where response cards were used. Both Narayan (1988) and Wheatly also, reported that students liked using response cards better than hand raising.

Write-on response cards allowed each student to respond to every teacher posed question. The students seemed to like using the response cards more than hand raising. During the initial response card practice session the entire class wanted to continue the lesson when the teacher announced that the lesson had reached its conclusion. Also, during the second hand raising phase students frequently asked when they would have the opportunity to use the response cards again.
Students enthusiastically passed out the response cards and markers at the beginning of each session. They were equally reluctant to turn in the response cards and markers at the end of the session. There were two criticisms heard about the response cards from a three students, one student said the markers smelled and two students stated they did not have enough time to write answers down their answers during the lesson.

Limitations

This study was limited by the following factors: subjects characteristics, teacher characteristics, absences, varying difficulty of curriculum content, the setting and time of school year, and the time of the school day.

Subject Characteristics

There were 25 student in this classroom, but only 22 students were used as subjects due to lack of sufficient data on three students. The students were either from the lower socioeconomic area surrounding the school or were bussed in from another lower socioeconomic area for racial balance. It is not known what the external generality would be to other SES classes.
Teacher Characteristics

The experimenter served as the teacher rather than the students' regular teacher. It is not known what type of results might have been obtained had the students' teacher instructed the content.

Absences

Student attendance was a problem throughout the course of the study. One student was habitually late to class in the morning. Five students were suspended at various times during the course of this study due to problems which occurred away from the study. Another student had chicken pox and was absent for an extended period. There were also attendance problems due to school responsibilities, in the school office and other classrooms.

Varying Difficulty of the Curriculum Content

The experimenter tried to make sure the content difficulty was the same for all the lessons. The use of a variety of materials to gather formation for the lessons caused some variability. Also, each students previous experience with content presented in any individual lesson could not be determined. In order to present
some science concepts to the class it was necessary to do some science demonstrations during some lessons while there was effort made to have an equal number of demonstrations in both hand raising and response card phases the impact of the individual demonstrations could not be determined. Also, the information instructed in this study was taught in units whose content overlapped sessions and even experimental phases, it is not known what results would have been obtained if the lessons in each session did not overlap with any other lesson.

The Setting and Time of School Year

The setting was a inner city school for regular education fifth graders. Results may have been different with other populations.

The study was conducted during the final grading period of the school year. There were numerous end of the year assemblies and other activities during this project. There was also a increase in absences as the end of the school year approached. There was also a increase in the students' resistance to due any academic work as the school year came to a close. To what degree these factors effected the study in not known.
Time of School Day

This study was conducted during the first period of the school day and often students came in the classroom upset about problems that occurred on the playground or school bus. Sometimes students had already been sent to the school office due to these problems. One student was suspended prior to the start of the school day which was upsetting to other students in the classroom.

Implications for Classroom Practice

Sixteen of the 22 students said that they preferred using response cards to hand raising. The students' regular classroom teacher stated she liked the response cards because they provided more opportunities for the students to actively participate in the classroom. The teacher also felt the students were generally more attentive during the response card sessions.

Write-on response cards have the flexibility to be used in a variety of academic areas. This flexibility comes from the fact that students can write students may write any response that can fit on the response card.
Strategies for providing students with increased opportunities to respond for students are important to educators because of the demonstrated relationship between OTR and academic achievement. Because of the diversity of skills in any classroom, educators are concerned about using instructional strategies that are the best suited for all the students, especially the students who are experiencing academic difficulty. Response cards demonstrated an ability to improve the academic performance of each student participant providing teachers with another instructional tactic to help students learn more efficiently in large group lessons.

The ability to develop instructional strategies that are helpful to a group of learners with varying skills is important to educators. Most regular educators are faced with a classroom occupied by a combination of at risk and non at risk learners. Frequently educators find a higher percentage of academically at risk students in the inner city of this country's public schools. Greenwood et al. (1984) found that the home environment of the students was not as important to the academic development of these children as the
development of increased opportunities to respond. Greenwood et al. found that in there analyzes of suburban classrooms and inner city classrooms that there was a difference in the OTR to respond in the two types of classrooms. In the inner city classroom the students has less OTR to instructional stimuli, but when OTR was increased the academic achievement of these inner city at risk students also increased. Greenwood et al. used the OTR strategy of classwide peer tutoring to increase the academic performance. They found that not only the at risk student who was tutored improved but the achievement performance of the tutor improved.

Another strategy often cited as effective in increasing OTR is choral responding. Both peer tutoring and choral responding are excellent tactics for increasing OTR. But, response cards has some advantages not seen in either classwide peer tutoring and choral responding. In peer tutoring the tutors must have some knowledge of the content area in order to be successful peer tutors. Response cards can be used both during the acquisition phase of learning as well as the practicing stage. When teachers use choral responding sometimes it is difficult to discern the individual responses and
the amount of noise created with a whole class responding chorally may not be desirable in many schools. Response cards have the individual students answers written on the card and held up for the teacher to see, they also do not require the students to make noise.

Other advantages of write-on response cards are that the students have opportunities to practice spelling the different key concepts and facts and the teacher can ask recall questions as well recognition type questions. The price of purchasing response cards and markers in very responsible approximately $40 for all the materials needed for this project. Write-on response cards in addition to being functional for any academic area can easily be stored in the classroom for easy access.

There are some limitations for response cards which should be noted. Teacher must ask questions which involve short answers due to the space limitations on the response cards. There must be clear firm rules for using the response cards to prevent time lost due to students playing with the response cards. Allowing students to draw on the response cards for 2 minutes at the conclusion of
the lesson proved effective in both the Narayan (1988) study as well as this study. Also, using the response cards requires more instructional time than when hand raising is used as the student response mode.

Suggestions for Additional Research

This study involved regular education student in an inner city fifth grade elementary classroom. The Narayan study involved regular education students in an inner city four grade elementary classroom. Future studies might look at the effect of response cards in earlier grades, middle school, and secondary classrooms. Also, researcher may look at the effects of response cards with students in self contained special education classrooms.

This study examined in a limited way the maintenance effects of response cards on student achievement other researchers may look more extensively at the maintenance effects as a result of response card use in instruction. Additionally, researchers may want to compare the effects of write-on response cards with pre-printed response cards.
Summary

The OTR and academic achievement has shown a consistent relationship in the literature. The literature also suggests academically at risk students can improve their skills by the use of OTR instructional strategies. The purpose of this study was to examine the use of the OTR strategy of response cards and student academic status (at risk and non at risk) of students.

Results indicated that both the academically at risk students and the non at risk students benefitted for the use of response cards. There was an increase in the rate of responding for both at risk and non at risk students during response card phases.

The average response rate for at risk students during the hand raising phase was .04 per minute with an accuracy of .03 correct response per minute. During response card phases the average rate of responding increased to .54 responses per minute and .37 correct responses per minute. The group mean for the entire class was even higher with a mean of .09 responses per minute and .07 correct responses per minute under hand raising conditions. The whole class mean during response card phases was
.72 responses per minute and .59 correct responses per minute.

During hand raising conditions there was an accurate responding rate of 8.2% while during response card phases the percentage of accurate responses improved to 88.5%.

The scores on the daily quizzes showed too much variability for most students to demonstrate a replicated positive effect for response cards. What was indicated was that none of the students' academic performance deteriorated during the response card phases. The data also demonstrated that during response card phases individual students increased their mean daily quiz scores over the individual scores during hand raising phases. The mean score for at risk student during both response card phases was 8.5 correct items on the 16-item quiz. The mean score for both hand raising phases was 6.1 correct responses for at risk students. What is disturbing about this finding is that despite the improvement of the at risk the mean score was still at a failing rate. In fact while none of the nine at risk students were receiving scores high enough to pass during hand raising conditions only three of the students improved sufficiently to have scores at a passing level. What was
encouraging was that finding 16 students scoring well enough on
the daily quizzes to receive a passing grade during response card
phases compared to only 8 students having a passing average
during hand raising phases.

The most exciting finding in this study was the relationship
shown between type of student responding and maintenance
effects on academic achievement, as shown on the unit tests. Each
student showed a correlation between student using response
cards during instruction and scores on the unit test. The limiting
factor about this data is that there were only four unit tests given
in this study. For example the mean group score for the class on
the first unit test where all the items were instructed during hand
raising conditions, was 53% correct. The group mean for the second
unit test where all the items were instructed under response card
conditions was 77%. During units test three and four which each
had an equal number of items instructed under hand raising
conditions and response cards conditions the data indicated that
those items instructed during response cards phases were
answered correct more often. On unit test 3 the group average on
response card instructed items was 73% as compared to 50% for hand raising instructed items. On unit test 4 the group average on response card instructed items was 61% as compared to 53% for hand raising instructed items.

Finally a large majority of the students preferred using response cards to hand raising. Students said it was more fun and they felt that they learned more when response cards were used. Response cards seem to be a good strategy to increase OTR and the data indicates that they have some maintenance benefits. Further response cards are an inexpensive method of providing a diverse group of students increased OTR and subsequently improved academic performance.
REFERENCES


APPENDIX A

PERMISSION SLIP
Parent Consent Form

I agree to allow my child to participate in a research study investigating the effectiveness of three response modes during whole class science instruction. This study will be conducted by Ralph Gardner, III, under the direction of Dr. William L. Heward, and will require approximately 35 minutes per school day for about 7 weeks. I understand that my child's identity will not be revealed in any publication, document, recording, video tape, photograph, computer storage, or any other form of report developed from this project. Additionally, I understand that I may withdraw my consent for my child's participation at any time.

__________________________
Name of Student

__________________________  __________________
Signature of Parent or Guardian  Date

__________________________  3/8/89
Ralph Gardner, III, Investigator  Date
APPENDIX B

DATA SHEET
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<tr>
<th>Date</th>
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<tr>
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<tr>
<td></td>
<td></td>
<td>C = Correct response</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I = Incorrect response</td>
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</table>

<table>
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<tr>
<th>Session</th>
<th>Observer</th>
<th>Second observer Y / N</th>
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<tbody>
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</table>

| 33      | R I      | C | C | C | R I |
| 35      | R I      | C | C | R I |
| 37      | C        | R I | C | R I |
| 39      | C        | R I | C | R I |
| 41      | C        | R I | C | R I |
| 43      | C        | R I | C | R I |
| 45      | C        | R I | C | R I |
| 47      | C        | R I | C | R I |
| 49      | C        | R I | C | R I |
| 51      | C        | R I | C | R I |
| 53      | C        | R I | C | R I |
| 55      | C        | R I | C | R I |
| 57      | C        | R I | C | R I |
| 59      | C        | R I | C | R I |
| 61      | R I      | C | C | C |
| 63      | C        | R I | C | R I |

| 39      | R I      | C | C | C | R I |
| 36      | C        | R I | C | R I |
| 38      | C        | R I | C | R I |
| 40      | C        | R I | C | R I |
| 42      | C        | R I | C | R I |
| 44      | C        | R I | C | R I |
| 46      | C        | R I | C | R I |
| 48      | C        | R I | C | R I |
| 50      | C        | R I | C | R I |
| 52      | C        | R I | C | R I |
| 54      | C        | R I | C | R I |
| 56      | C        | R I | C | R I |
| 58      | C        | R I | C | R I |
| 60      | C        | R I | C | R I |
| 62      | C        | R I | C | R I |
| 64      | C        | R I | C | R I |
APPENDIX C

OBSERVER ANSWER SHEET
Lesson 10

1. reproduction - reproduktion - reproducsion
2. pollen - paullen - pollin
3. two - tuo - 2
4. insects - nsects - ensects
5. wind - wend
6. most - moost
7. sweet odor - swet odor - sweet odar
8. stamen - stymen - stamin
9. sticks - stecks - stics - stiks
10. carries - carrys - karries
11. grasses - grases - grassies
12. tube - toube
13. ovule - ouvle - ofule
14. fertilization - furtlization - firtlization
15. seed - seid
16. plant - plannt
17. embryo - embreo - mbryo - imbryo
18. gremination - girmination - germenation
19. photosynthesis - fotosynthesis - photoosinesis
20. botantists - botantists
21. patterns - patturns - paterns
22. alike - alieke
23. flowers - flours - flawers
24. cones - cownes
APPENDIX D

SAMPLE DAILY QUIZ
Quiz 1

1. What is the condition of the air around us called?

2. Name a way that weather effects our behavior.

3. What is the layer of air around the earth called _________.

4. We must we understand _____ better before we can understand weather?

5. Air has ______ and takes up space.

6. The atmosphere is made up what?

7. What part of the atmosphere is closes to the earth surface?

8. Where are most of the gases in the atmosphere.

9. The atmosphere reaches from the earth surface to about ____ km above the earth.

   a) 180 km  b) 100 km

   c) 8000 km  d) 800 km

10. The _____________ is the part of the atmosphere closes to the earth.

    a) ionosphere  b) mesosphere

    c) troposphere  d) stratosphere
11. ________ causes the gases to be pulled down to the earth's surface.
   a) rain   b) snow
c) electricity  d) gravity

12. The two main gases in the atmosphere are ________
    and ______
   a) nitrogen and oxygen   b) oxygen and carbon monoxide
   b) nitrogen and fumes    d) helium and oxygen

13. Air pressure is the heaviness of air. TRUE or FALSE?

14. Most weather occurs in the troposphere. TRUE or FALSE?

15. Gravity pushes the gases away from the earth. TRUE or FALSE?

16. Hurricanes occur in the ________________
   a) exosphere   b) ionosphere
c) mesosphere   d) troposphere
APPENDIX E

SAMPLE UNIT TEST
Unit Test

1. A neutron star is much bigger than a white dwarf. True or False

2. A _______ ______ is a region in space that was once occupied by a star.

3. A neutron star has more matter than a white dwarf. True or False.

4. Our galaxy is called the _______ _______.

5. Our galaxy is about _______ light years from edge to edge. a. 100,000 c. 10,0000
   b. 50,000 d. 200,000

6. Our galaxy is so large that it takes about _______ million years for the sun to go around once.

7. _______ stars follow the six stages.
   a. all c. only a few
   b. not all d. every

8. Stars that collapse into white dwarfs sometimes _______.
9. Some scientists think the gravitational pull of a neutron star can be so great that the star _______________.
   a. grows   c. falls
   b. disappears d. lights

10. The sun and it's __________ are moving around the center of the galaxy.

11. Stars that collapse into white dwarfs may explode and become ________________.
   a. green   c. very bright
   b. blue    d. bigger

12. Many scientists believe that all the objects in our galaxy revolve around it's __________.

13. As the sun moves around the galaxy it takes a long time. It is possible that the sun is just now returning to the place where it was before __________.
   a. people   c. trees
   b. animals  d. dinosaurs
14. Some people believe that the gravity of a black hole is so great that not even _______ can escape.

15. A super nova must explode before a neutron star can be formed. True or False.

16. When a very large star explodes violently it is called a _______

17. Energy causes stars to appear to glow. True or False

18. The sun _______ like the earth and other planets.

19. Polaris is found above _______

   a. sun   c. south pole

   b. north pole   d. little dipper

20. As matter continues to press together the star’s _______ rises.

21. Most zodiac constellations are named after people and animals. True or False.

22. Name a constellation other than the Big Dipper.

23. It takes the earth 365 days to circle the sun. True or False.

24. Mars is called the _______ planet.
25. The planet Mercury is ____________
   a. dry and hot       c. cold and wet
   b. cold and wet      d. wet and hot

26. Another name for Polaris is ____________.

27. People could live on Venus. True or False.

28. The sun and all the objects that travel around it make up the ____________.

29. There are other solar systems in the Milky Way besides ours. True or False.

30. Scientists believe that our sun is _______ million years old.

31. Astronomers think that other solar systems may have.
   a. Disney World       c. rain
   b. air                 d. life

32. Name one of the "major" planets.

33. Saturn's rings are formed by billions of pieces of ice. True or False.

34. Jupiter is the _______ of all the planets.

35. One year on Saturn is equal to 30 earth years. True or False.
36. The ______ is the largest part of the solar system.

37. Another name for the satellites that travel around the planets is ________.
   a. moons       c. constellations
   b. stars       d. clouds

38. The temperature on Mars are ________ than the temperature on Earth.

39. Saturn is smaller than ________.
   a. earth      c. Mars
   b. Venus      d. Jupiter

40. Other than our planet, how many planets are in our solar system?
APPENDIX F

STUDENT PREFERENCE INTERVIEW FORM
STUDENT INTERVIEW FORM

Student ______________________ Date ____________

Interviewer ______________________

1. What was your favorite way to answer questions?
   __ Hand raising  __ Response card

2. Which way of answering did you feel helped you the most?
   __ Hand raising  __ Response card

3. Which way of answering questions helped you get the best grades?
   __ Hand raising  __ Response card

4. What are the thing(s) you liked about hand raising?

5. What are the thing(s) you didn't like about hand raising?

6. What did you like about using response cards?

7. What didn't you like about using response cards?

Do you have anything else you would like to say or ask about the way you were instructed in science?
APPENDIX G

A SAMPLE LECTURE OUTLINE
Yesterday we talked about the fact that a star has life. Today we are going to talk more about the life stages of a star. New stars are "born" and old stars are "dying".

Changes in stars take place over millions of years.

Not all stars will go through every stage.

1. A star is formed from dust and gas in space.

   A cloud of dust and gas found in space is called a nebula.

   The dust and gas comes together because of gravitational attraction. A great amount of matter must collect for a new star to be formed.

   There must be about as much matter as there is in the sun. As the matter in the nebula presses together, it gets hot.

2. Just before a new star is born it has a red glow. As matter continues to press together, the star's temperature rises.

   Finally, the "fuel" of which stars are made begins to "burn".
It does not burn like a fire. Instead, hydrogen atoms combine to form helium atom, giving off energy. A star can be described as a ball of burning hydrogen gas.

3. Most stars are very hot. They are blue-white. As more of a star's hydrogen is used up, it becomes cooler. It may turn white. When even more hydrogen is used up the star cools more and turns yellow. Most middle-age stars like the sun are yellow.

4. A star beginning old age often swells up to form a red giant. A red giant is a star that may be many times larger than the sun. Scientists believe that the sun will enter this stage millions of years from now.

5. After a while a red giant begins to collapse into a smaller star. It becomes hotter and appears white in color. A star at this stage is called a white dwarf. It does appear bright. It is about as big as the earth.
6. Once most of the star’s fuel is gone it will enter the last phase of its life. The star will become a black dwarf. It has no heat or energy.

Sometimes white dwarfs will explode; these are called nova.

Supernova are when large stars explode violently.
APPENDIX H

SAMPLE INSTRUCTIONAL TRANSPARENCIES
To understand weather better, we must first understand air better.

Around the earth is a layer of air called the atmosphere.

The atmosphere reaches from the earth surface to about 800 km above the earth.
The atmosphere has several parts. The closest part to the Earth surface is called the troposphere.

Most weather occurs in the troposphere.
The other parts of the atmosphere are called stratosphere, mesosphere, ionosphere, and exosphere.
APPENDIX I

GRADING SCALE
The grading scale used to determine letter grades for student averages during the experimental phases.

<table>
<thead>
<tr>
<th>Daily Quiz Grading Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 = 100% A+</td>
</tr>
<tr>
<td>15.5 = 96.8% A</td>
</tr>
<tr>
<td>15 = 93% A-</td>
</tr>
<tr>
<td>14.5 = 90% A-</td>
</tr>
<tr>
<td>14.0 = 87.5% B+</td>
</tr>
<tr>
<td>13.5 = 84.3% B</td>
</tr>
<tr>
<td>13.0 = 81.2% B-</td>
</tr>
<tr>
<td>12.5 = 78.1% C+</td>
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<td>12.0 = 75% C</td>
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<td>11.5 = 71.8% C-</td>
</tr>
<tr>
<td>11.0 = 68% D+</td>
</tr>
<tr>
<td>10.5 = 65.6 D</td>
</tr>
<tr>
<td>10 = 62.5% D-</td>
</tr>
<tr>
<td>Below 10 F</td>
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