An intensive rehearsal technique for effecting retention in learning disabled students

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Abstract

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AN INTENSIVE REHEARSAL TECHNIQUE FOR EFFECTING RETENTION IN LEARNING DISABLED STUDENTS

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THE PROBLEM

Introduction

Education is currently under critical examination. Social and political leaders are acutely concerned with SAT scores, even though these scores are now coming back up slowly. Their concern stems from a belief that lower test scores indicate students are less well prepared for the world of work. This situation will ultimately result in lower productivity in our society.

Teachers are under attack because they allegedly are not educating students so that the students can function in a positive manner in our increasingly complex world society. Educators are also very concerned about the problem. In view of the increased societal and governmental pressure, and the emerging need for answers to these problems, educators are seeking to identify and define general and specific areas of weakness and devise measures for offsetting these shortcomings.

One aspect of this problem was manifested in the large number of students who had been found to possess learning problems in mathematics. Wood (1980) stated that his diagnosed caseload had become increasingly weighted with children who were referred because of their disability in arithmetic. Diagnosis has revealed, in almost all of the cases, lack of mastery of the mathematics facts or combinations. The number of students in special education with arithmetic problems was greater than ever before. What should be the curriculum for children with these learning problems? For children with problems that are not too severe, it was natural that some modification of the existing curriculum should be considered.

Most methods and survey books on children with mild learning problems, according to Wood (1980), discuss the teaching and learning of language, reading and arithmetic and the diagnosis and remediation of these problems. However, language and reading problems seem to have been studied much more extensively than have arithmetic problems. It is imperative that more attention be given to devising methods which are successful in teaching students with arithmetical learning problems.

A learning disabled student has characteristically been defined as one who is unable to read but who is good in arithmetic; today however, because of changes in both reading and mathematics instruction throughout the country, the learning disabled child may be able to read with some degree of efficiency, but he may be totally unable to compute. (Wood, 1980)

Wood (1980) further states that he interviewed 85 mathematics teachers in grades five through nine. Each was asked to respond to the question, 'In what way would you like your students to be better prepared when they come to you?' The first answer given by 68 of the 85 teachers was, 'I wish they had mastered their basic principles.'.

The present study represents an effort to observe the effects of a specific method of teaching basic arithmetic principles to learning disabled students in an alternative educational setting in Waterloo, Iowa.

The study is a response to the expressed concerns of teachers and to a recognition that most research efforts have focused on reading disorders; while by comparison, there has been very little research devoted specifically to arithmetic performance in learning disabled children. (Krakow and Curcio, 1978)

The reformational thought of the sixties and early seventies espoused the philosophy that 'more is better' and consequently new and diverse methods of teaching reading and arithmetic were developed and marketed as the avant-garde methods of teaching. According to Wood (1980), by de-emphasizing computation and mastery, we may have taken away the very aspects of mathematics which some students could learn and in which they could develop some competency. A lack of mastery of arithmetic principles appears to be a real pitfall for learning disabled students and quite possibly injures and cripples in a computational sense, some of our future mathematicians. Unfortunately, proven traditional methods were considered unfashionable and were discarded or employed minimally during these years. Teachers tended to throw out the baby with the dirty bath water.

Currently, it appears that we are recognizing the negative and positive aspects of that era and are beginning to sort them out. This study does not represent a new, magical method of teaching. Rather it combines the traditional educational concepts and practices with the most significant aids to education to arise out of the sixties and the seventies, the computer.

The Problem

The problem chosen for this investigation came to the attention of the writer when he was employed in an alternative education program in Waterloo, Iowa. He was disturbed by the large number of learning disabled students who could not retain basic arithmetic concepts.

The writer wondered whether the problem was unique to the students assigned to his classes. Therefore, he questioned other special education teachers who had learning disabled students to ascertain the extent of the problem. The inability of learning disabled students to retain basic arithmetic facts appeared to be quite common. Special education teachers said that basic arithmetic facts appeared to be "forgotten" quickly, sometimes within the period of a single day. They cited instances where apparent mastery and the loss of the knowledge taught occurred overnight.

The problem posed many questions for these teachers. How should they teach their students so that the knowledge and skills would be retained? Should they reteach students by the same method used in the first instance? Should they try other methods? What alternative methods might they try?

Some teachers would reteach by the same method which failed the first time and failure results were generally repeated. Some teachers tried a different single method on their second attempt-written drill. Poor results were commonly obtained. Teachers attributed the students' failure to laziness, lack of effort and concentration, frustration, a plateauing of intellectual capacity that appeared to stop learning altogether, rebellious anti-social behavior by the student to "get even with society", and to the "nature of the disability itself". The problem persisted.

Purpose of the Study

The purpose of this study was to determine whether or not learning disabled students would materially improve their ability to retain basic arithmetic facts when the teacher utilized a specific intensive rehearsal technique. The study was designed to determine if learning disabled students who are taught basic arithmetic facts with an intensive rehearsal method will achieve a significantly higher rate of retention than they have achieved with previously used methods.

Significance of the Study

Better methods for teaching the basic arithmetic facts to learning disabled students must be found. Methods must be examined for their contribution to student retention of basic arithmetic facts. Finding such methods would offer teachers a means of effecting permanent gains in pupil achievement and establish the base for continual learning.

If research can help find more suitable methods for teaching mathematics, then the learning disabled students will achieve significant grade advancement, reduce their frustration toward learning, develop greater self-confidence and self worth, which will ultimately enable them to contribute to society in a more productive manner. This research will also suggest ways teachers can systematically study additional teaching methods and determine the efficacy of them.

Limitations of the Study

The conduct of the study was restricted by the following conditions:

1. Random sampling in the selection of the students was not employed. Selection of participants was restricted due to the limited number of learning disabled students with the specific handicapping condition. Thus, the researcher was only able to use ten arithmetic learning disabled male students who were identified by the Wide Range Achievement Test (Jastak and Jastak, 1965) and by the psychological and academic testing services of the Waterloo, Iowa school district. The limited size of the population and the sampling procedure restrict the generalization of the results.

2. Students were pretested and post-tested with the math section of the WRAT only. Students may manifest gain due to familiarity with the test, although this is unlikely because of the time between pre- and post-testing. This time period was eight months.

3. The instruction period was administered by two persons: the teacher-researcher and a trained aide.

Definition of the Terms

In the interest of clarity the following terms are defined:

1. Intensive Rehearsal Method - a system consisting of three elements of attack on the problem of retention of basic arithmetic skills of addition, subtraction, multiplication and division. The method consists of three elements:

a. Spectrum Mathematics Series

b. Matheputer

c. Concentrated Mode of Teaching

2. Spectrum Mathematics Series - consists of consumable arithmetic texts for grades three through eight. This series focuses on the development of basic arithmetic processes.

3. Matheputer - refers to a computer which is programmed to present basic arithmetic problems in addition, subtraction, multiplication and division and can be programmed to present the problems at different rates so that the teacher and/or aide can control the speed of delivery and rate of response.

4. Concentrated Mode of Teaching - refers to one on one instruction and individual monitoring of the Spectrum and Matheputer phases of the intensive rehearsal methods.

5. Learning Disabled - refers to a designation applied to children who experience difficulty in one or more academic subjects such as reading or arithmetic and for whom the disability cannot be explained in terms of low intelligence, obvious brain damage, or emotional maladjustment. (Martin, Barclay, Developmental Disorders of Childhood. In Jeanette Johnson (Ed.) Abnormal Psychology, (1981) p.396.)

6. Retention - refers to preservation of the effects of experience--a learning that makes recall or recognition possible.

7. Wide Range Achievement Test - Arithmetic subtests: countting, reading number symbols, solving oral problems, and performing written computations. Level I is designed for use with children between the ages to 5 years 0 month and 11 years 11 months. Level II is intended for persons from 12 years 0 months to adulthood.

SECTION 2

REVIEW OF RELATED LITERATURE

The purpose of this chapter is to examine studies that have investigated various methods of teaching arithmetic and the relative success of these methods in promoting pupil achievement. Studies devoted to the mastery of basic arithmetic facts, as disclosed by short and long-term retention, were of particular interest to this researcher. The work of Myers, Thornton, Swett (1978), Wood (1980), Jones (1979), and Austin (1982) serve as the cornerstone for research in this area.

Attempts to deal with this problem have encouraged these researchers to employ a number of promising methods. Much of the research is based upon diagnostic and remediation projects in arithmetic that date from the early 1920's according to Green and Buswell (1930).

The approaches of the researchers whose work is pertinent to this study appear to fall into four categories: philosophical - relating to the attitudes of researchers regarding fundamental learning approaches; methodological - referring to a particular procedure or set of procedures employed by researchers; developmental - following the stages of learning readiness e.g. Piaget's developmental stages; material emphasis - research regarding the quality and use of resource materials in teaching basic arithmetical principles. The discussion that follows presents samples of these approaches and sets the stage for this study.

Philosophical Position

Johnson and Myklebust (1967) argued that for arithmetic learning the remediation must be based upon the nature of the deficit not on the improvement of quantitative thinking. Academic instruction following this philosophy is based on an assessment of a child's general abilities; instructional prescription is based on specific strengths and/or weaknesses reported Austin (1982). The philosophy of Johnson and Myklebust (1967) has dominated instruction within the field of learning disablities over the past twenty or thirty years according to Haring and Bateman (1977).

Supporting this philosophy, Jones (1979) stated that a blend of awareness of learning strengths and of the developmental processes is essential in the teaching of mathematics concepts. The identification of sensory modality strengths whether visual, auditory or kinesthetic will provide a classroom teacher with information needed to plan a mathematics program for a learning disabled child.

Another team of researchers postulates that the most pervasive deficit which may extend across the academic skill areas is memory and may involve:

1. memory storage deficit
2. experiential synthesization deficit

3. retrieval deficit

Ginsberg and Opper (1969).

Houck, Todd, Barnes and Englehard (1980) concurred with this position when they stated that a method for student success would have to be keyed to the child's capacity for internal manipulation of information along with an efficient memory system.

Bruekner and Bond (1955), Carter and Dapper (1972), and Frostig and Maslow (1973) espoused a similar philosophy and asserted that basic arithmetic principles should be learned systematically and practiced until they become automatic; that basic principles should be stressed and that a mathematics improvement program should be begun by remediating any lack of knowledge of basic arithmetic principles.

Other researchers expressed some misgivings about these philosophies and the implication of them for teaching mathematics. Bartell (1975) stated that computational practice alone would seem insufficient to guarantee a transfer of student knowledge to work problems which implies that both computation and application employing basic arithmetic principles is required to develop fluency. Lesh (1978), summarizing, stated that, it is often unclear whether teachers should try to teach learning disabled youngsters using techniques that are qualitatively different from those they use with normal children or normal slow learners, or whether they should use the same techniques-- only do it better, perhaps with more practice and drill. Another researcher, Wood (1980), posited that by deemphasizing computation and mastery we may have taken away the very aspects of arithmetic which some students could learn and in which they could develop some competency. A lack of mastery (of basic arithmetic principles) appears to be a real pitfall for learning disabled children and quite possibly injures or cripples, in a computational sense, some of our future mathematicians.

Methodological Position

Basic arithmetic principles for teaching mathematics were drawn from the methodological approaches advocated by other researchers. Sullivan (1973), in the Basal Mathematical Program employed a method which requires no reading and stresses computation with addition, subtraction, multiplication, division of whole numbers, fractions and decimals, it was designed for children grades one through six. Programmed textbooks with self correction and immediate feedback were used. Similar procedures were employed in this study.

Both MacDonald (1982) and Durham (1981) advocated methods that present basic arithmetic principles through concrete experience. Students are provided hands-on manipulation experience. Story problems are used to teach fundamental arithmetic properties and to increase number fluency and problem solving skills. The present study used texts, with computational and story problems, that specify problem difficulty according to age and gradecriteria.

Thornton and Reulle (1978) recommended that the teacher document the problems and characteristics (of students) by saving samples of the child's work, recording anecdotal information, noting the child's responses and keeping an up-to-date file pinpointing the child's major strengths and weaknesses. They further advocated noting attitudinal factors of the child, working through strengths, setting realistic short-term goals, avoiding repeated failures and focusing of attention on relevant cues to develop memory. While these researchers did not present a specific method for sequencing work, they did provide many recommendations which could be used in developing sequencing strategies, some which were used in the present study e.g. working through strengths, noting students' responses, attitudes, and cueing to aid memory.

Coble (1982) developed a method called "Beat Your Record", a structured mathematics testing/learning station activity. During a daily 20 minute period, an alternative testing and learning schedule was used to produce a high level of on-task behavior and greater student interest. The teacher selects a specific goal that slightly surpasses a student's previous achievement. The student is motivated to achieve the goal that is well within his reach. The present study employed a method similar to Coble's. This goal oriented approach is further enhanced by using a task analysis technique developed for use with slow learners by Glennon and Wilson (1972).

<u>Developmental Position</u>

Some researchers look at learning basic arithmetic principles from a developmental standpoint. However, Austin (1982) stated that writing and research on teaching arithmetic deficiences of learning disabled children did not seem to concentrate on the structure of arithmetic or the child's stages of development. Contrary to this contention, Krakow and Curcio (1978) tested twenty-eight learning disabled boys, attending a private school, to determine their figurative, operational , and arithmetic achievement. Results indicated that <u>concrete operational</u> level early in the year predicted progress during the year. The mean arithmetic grade was 4.6 early in the year and 5.9 later in the year.

Austin (1982), Skrtic (1980), Greenstein (1976) also studied a group of learning disabled junior high students and found them functioning at Piaget's concrete operational stage. Skrtic stated that mathematical techniques for learning disabled students should involve concrete or pictorial, in addition to symbolic, representations of mathematical problems. Difficulty with symbols, multiple mental manipulations and abstract concepts were observed by Greenstein (1976) in a study of 82 learning disabled adolescents compared with 1200 normal students.

<u>Materials Position</u>

Learning materials are regarded as primary facilitators of learning by some researchers. Kohl (1974) posited that game playing produces benefits which include strategy, foresight, and organized thinking. Golick (1973), an experienced teacher and psychologist, has worked extensively with learning disabled children using a deck of cards, informal and unthreatening to any child, both for diagnosis and remediation.

Nolen (1967), Klieman and Humphrey (1984) employed high interest activities, e.g. microcomputers. Significant academic gains occurred with twenty-nine learning disabled students, 7-13 years of age, when the computer was used three to four times a week, for 15-20 minutes, for a maximum of ten weeks. Results indicated that in addition to the fun, the children enjoyed improved communication skills, an increased ability to handle frustration, academic progress and independence within their learning environments. Success with the computer enhanced their self esteem.

From tests generated by a computer, Hestwood and Taylor (1973) could diagnose a student's specific computational deficiencies in the basic skill areas and provide worksheets of problems geared to those deficiencies. Similar to the matheputer used in the present study, Hestwood and Taylor's diagnostic procedure heightened individual attention and increased textual work activity through drill and practice and application problems.

Swett (1978), Homan (1970) and Turnbull and Schultz (1979), offered suggestions for material usage namely organizing the board and worksheets well, allowing the child different ways to provide feedback to the teacher for evaluation, e.g. tape recorder as opposed to only written work, a list of basic mathematic words and phrases to be studied.

Finally, McLeod and Armstrong (1982), found commercial materials, when used with junior and middle grade students, outranked teacher made materials. We might conclude from this research that teachers might profitably employ purchased or commercial education materials rather than developing materials of thier own.

SECTION 3

METHODOLOGY

The categories discussed in the Review of Related Literature; philosophical, methodological, developmental and material are summarized as follows with regard to their influence on the researchers methodology.

This researcher employs a philosophy that draws from selected features of the philosophical positions. The philosophical positions provided the guiding principles for this writer's study and established the basis for using learning strengths to remediate weaknesses in learning the basic arithmetic principles.

Learning basic arithmetic principles in this present study was tied to systematic memory storage based on experience in the processing and application of basic principles.

Remediation of deficit areas in basic arithmetic principles was one of the basic aims of this research. Emphasis was placed on learning basic arithmetic principles employing computation, drill and practice, and application in this research.

This researcher employed several techniques which have been tested by other researchers who share his interest in improving the mathematical skills of elementary school children. Specifically, this study combined computation, strategies, story problems, goal-oriented activities that were age-appropriate and anecdotal case histories to create an intensive and individualized mathematics program for learning disabled students.

The subjects in the present study ranged from the junior high school to the high school level. Difficulties similar to those of Greenstein and Skrtic were observed by this researcher. However, emphasis was placed on determining each student's grade level of functioning and developing a remediation program geared to that student's strengths and weaknesses without regard to developmental level. A developmental stage could have been determined and assigned to each student via their diagnostic testing results but this was deemed to be a less direct attack on the students' learning difficulties.

There appears to be a wide cariety of materials to facilitate the acquisition of basic arithmetic principles. A teacher must be highly selective when choosing the materials for each student as well as being cognizant of the need for teacher-developed supplements if an individualized program of instruction is to be effective.

Methodology

The intensive rehearsal method involved three elements: Spectrum, a consumable arithmetic text with pre and post tests in each unit comprised of written drill and practice exercises in the basic skills of addition, subtraction, multiplication and division and the application of these skills in story problems; the Matheputer, which is a computer program designed to present basic arithmetic problems in addition, subtraction, multiplication and division; and a concentrated mode of teaching, which refers to one-on-one instruction and individual monitoring of the Spectrum and Matheputer phases of instruction.

Students were pretested with the Wide Range Achievement Test to determine their strengths and weaknesses. Remediation was then planned at the level specified by the WRAT results. The Matheputer was utilized for the type of problem e.g. three digit addition; the speed setting was placed at an estimated speed of responding given by the WRAT success level, e.g. ten seconds between problems. Individualized instruction was then administered so that specific problem areas could be addressed through basic facts instruction and problem solving. Each student was post-tested at the end of each unit. Ninety percent accuracy was required to progress to the next unit. The student would not be given new tasks if less than ninety percent was achieved. Students were post-tested with the WRAT at the end of the school year to see if they retained more of the material taught than had been retained with other methods used prior to this research.

Context of the Study

The study took place in an alternative education classroom in Waterloo, Iowa. This classroom served students who, for academic and behavioral reasons, were unable to function successfully in the regular school environment. The school is located in northeast Iowa in a metropolitan area of approximately 100,000 people.

Subjects

Subjects for this study consisted of ten learning disabled students. Eight were urban residents and two were rural. Nine were caucasian and one was black. Ages ranged from 13 to 17. All were one or more years behind grade level in math. On the average these ten students were between 3.4 and 4.5 years below grade level on the math section of the WRAT Levels I and II respectively. Research indicates that other than the basic defining variables of relatively normal IQ and academic deficiencies there are no other common characteristics that cut across all learning disabled children. (Ryckman, 1981). Accordingly, this subject group was selected on the basis of their academic deficiency in math.

Procedure

One teacher, who was the researcher, and one trained aide, implemented the teaching technique each school day for a period of one school year.

The technique (See Flow Chart, Figure 1, p. 21) involved a precise procedure that required each student to be evaluated with the WRAT diagnostic math test, Levels I and II, to determine an entry level of functioning. After determining the WRAT level performance the teacher examined the Spectrum Math Series to select the appropriate pre-test in the Spectrum text.

The expected success level in the Spectrum text was to equal .5 grade levels below the WRAT grade equivalent. Each student was then pretested for proficiency at the expected success level of a unit within the Spectrum text. If a student scored below 90% the next lowest pre-test was administered until 90% proficiency was demonstrated. If a student initally scored at 90% or higher, the next higher pre-test was administered. This procedure was continued until the student scored below 90%.

The Spectrum unit is designed to remediate weaknesses and

Figure 1

Flow Chart Regarding
Student Intake and Progression

Student Achievement Level determined by Wide Range Achievement Test Mathematics Section

Teacher examines Spectrum Test to determine appropriate pre-test based upon Wide Range Achievement Test performance. Expected success level equals .5 grade levels below Wide Range Achievement Test grade equivalent.

Student pre-tested for Proficiency at the expected success level on a Unit with Spectrum text.

Proficiency determined: If student scores at 90% or higher, the next highest pre-test is administered. This procedure continues until the student scores below 90%

Proficiency determined: if student scores below 90%, the next lowest pre-test is administered

Spectrum unit designed to remediate weaknesses and to develop new skills.

Matheputer programmed for problem type and speed set to facilitate remediation in deficiency areas and to develop new skills, 90% accuracy required.

Computational skill instruction and practice in Spectrum unit serving as a retention building function.

One on One instruction initially and when needed during unit progression.

Word Problem logic and computation in Spectrum unit employing transfer function to enhance retention.

Student posttested at end of Spectrum instructional unit.

Student scores 90% and moves to next unit in sequence in Spectrum text.

Student fails to score 90% and is retained in present Spectrum unit receiving one on one instruction, computation and word problem and matheputer practice until 90% posttest level is achieved.

to develop new skills. When the specific problem area was determined computational skill instruction and practice in the Specific Spectrum unit served a teaching and retention building function. Word problem logic and computation in the Spectrum unit served a transfer function. Transfer activities also serve to increase retention.

One on one instruction and close monitoring was provided for computational and word problem logic as students progressed through each unit.

In addition, a computer was programmed to provide specific types of problems. The speed of presentation was controlled in order to facilitate remediation in computational deficiency areas and to develop new skills. When students attained 90% accuracy they were permitted to begin the next lesson in the unit.

Each student was post-tested at the end of the target Spectrum unit. If the student scored 90% or better he was allowed to take the pre-test for the next unit in the Spectrum text. If the student failed to score 90% he was retained in his current Spectrum unit and received one on one instruction, in his specific deficit area, augmented with word problem logic and computer practice until a 90% post-test level was achieved.

Each student was post-tested with the WRAT, Levels I and II, at the end of the year to determine if significant advancement had taken place.

SECTION 4

RESULTS

The ten subjects were selected for this study on the basis of mathematics deficits determined by the Wide Range Achievement Test. The mathematics section of the WRAT, Levels I and II, was administered to each subject at the beginning of the school year and repeated at the end of the school year.

The ten students ranged in age from 13 through 17. One of the ten students had completed grade 11 prior to the year the study was conducted; the other nine had completed grades 7, 8 and 9. Table 1, page 24, shows that WRAT, Level I pretest grade equivalents ranged from 2.4 for Student F to 9.0 for Student A with a mean grade equivalent of 4.76. The WRAT, Level I post-test grade equivalents ranged from 5.2 for Student D to 14.9 for Student A. The mean grade equivalent was 7.40.

The average grade equivalent gain per year prior to treatment was calculated by dividing the pretest WRAT, Level I grade equivalent by the grade completed.

For example, Student A obtained a post-test grade equivalent score of 14.9 and a pretest equivalent score of 9.0. The difference between these two scores, 5.9, represents the average gain score. The gain score 5.9 was then divided by the average rate of yearly gain prior to treatment. The average rate of gain prior to treatment was determined by dividing the pretest grade equivalent score by the

TABLE 1

Wide Range Achievement Test
Pre-Test and Post-Test Scores, Gains,
Means, Program Impact Indices

Level I

1 Student	2 Age	3 Grade Completed	4 Pre-Test Grade Equivalent	5 Average Grade Equivalent Per Year	6 Post-Test Grade Equivalent	7 Grade Equivalent Gain	8 Program Impact Index
A	17	11	9.0	.82	14.9	5.9	7.2
B	13	7	5.7	.81	7.0	1.3	1.6
C	14	8	5.5	.69	8.2	2.7	3.9
D	14	8	3.9	.49	5.2	1.3	2.7
E	13	7	4.5	.64	6.3	1.8	2.8
F	15	9	2.4	.27	6.7	4.3	15.9
G	13	7	3.9	.56	5.5	1.6	2.9
H	13	7	3.6	.51	5.3	1.7	3.3
I	13	7	3.6	.51	6.1	2.5	4.9
J	14	8	5.5	.69	8.8	3.3	4.8
		TOTALS --	47.6	5.99	74.0	26.4	50.0
		MEANS --	4.76	.60	7.40	2.64	5.0

Average grade equivalent for the group = 4.76 = 7.40

2.64 = average gain for the group

5.0 = average program impact index

number of years of school completed. In this instance, Student A has a pre-test grade equivalent score of 9.0 and has completed 11 years of school. Thus the ratio is 9.0/11, which yields an average rate of gain score of .82. The amount of gain during the course of the study, 5.9, was then divided by the average rate of gain from the years prior to the study, .82, to obtain the program impact index of 7.2. The program impact index represents the increase in yearly gain achieved by substituting the intensive rehearsal method for those methods that had been used in preceding years.

Table 2, page 26, shows that WRAT, Level II pre-test grade equivalents range from 2.3 for Student F to 6.9 for Student A with a mean grade equiavelent of 4.2. The WRAT, Level II post-test grade equiavelent ranged from 3.4 for Student D to 12.9 for Student A. The mean grade equivalent was 6.4.

For example, Student A's pre-test grade score equivalent on the Wide Range Achievement Test, Level II, was 6.9, his post-test Wide Range Achievement grade equivalent was 12.3, his expected grade advancement based on performance prior to treatment was .68 per year and his actual grade advancement achieved on the Wide Range Achievement Test, Level II following the treatment equalled 5.4. His program impact index equals 8.6. The program impact index tells us that Student A's growth score was 8.6 times greater when using the intensive rehearsal method than the average growth score attained with other treatment methods.

TABLE 2

WIDE RANGE ACHIEVEMENT TEST
PRE-TEST AND POST-TEST SCORES,
Gains, Means, Program Impact Indices

LEVEL II

1 Student	2 Age	3 Grade Completed	4 Pre-Test Grade Equivalent	5 Average Grade Equivalent Per Year	6 Post-Test Grade Equivalent	7 Grade Equivalent Gain	8 Program Impact Index
A	17	11	6.9	.63	12.3	5.4	8.6
B	13	7	5.3	.76	5.7	0.4	.5
C	14	8	6.1	.76	9.0	2.9	3.8
D	14	8	2.3	.29	3.4	1.1	3.8
E	13	7	2.9	.41	4.5	1.6	3.9
F	15	9	2.3	.26	5.9	3.6	14.1
G	13	7	3.1	.44	4.9	1.8	4.0
H	13	7	2.9	.41	4.4	1.5	3.6
I	13	7	4.4	.63	5.7	1.3	2.1
J	14	8	6.1	.76	8.0	1.9	2.5
TOTALS --			42.3	5.35	63.8	21.5	46.92
MEANS --			4.2	5.3	6.4	2.1	4.7
Average grade equivalent for the group		=	4.23	=	6.4	2.1 = average gain for the group	4.7 = Average program impact in

The bar graphs, (see Appendix), show the pretest and post-test Wide Range Achievement Test, Levels I and II grade levels for the individual subjects. These figures illustrate the differences between the fall and spring levels of individual mathematics functioning. These graphs also show that the intensive rehearsal technique is effective to varying degrees with each individual student and that this technique can be applied successfully to students in Wide Range Achievement Test grade levels from 2.3 to 14.9.

These graphs further tell us that students from varying grade levels can be taught in the same classroom. This fact has implications for mainstreaming students and individualizing instruction in the regular classroom since the treatment population was taught in one classroom.

The summary for correlated t measures, in Appendix B, shows a WRAT, Level I pre-test and post-test t-value of 5.9 which is significant at the .01 significance level. The summary for correlated t measures in Appendix C shows a WRAT, Level II pre-test and post-test t-value of 4.68 which is significant at the .01 significance level.

Since the t value is greater than the critical value of a t at the .01 significance level, the probability of an error in the interpretation of the t-value is less than .01.

The program impact factor is determined by dividing the treatment gain by the expected grade advancement per year based on an average rate of gain prior to treatment. The treatment gain is determined by subtracting the sum of the pre-test

WRAT grade equivalent and the expected rate of gain from the post-test WRAT grade equivalent. The program impact factor differs from the program impact index in that it represents a value exclusive of rate gain prior to treatment.

Table 3, page 29 shows the program impact factor on Level I of the Wide Range Achievement Test. Student A's growth rate on the Wide Range Achievement Test, Level I, was 6.2 times greater with the intensive rehearsal method exclusive of his .82 expected grade advancement based on all methods used prior to treatment. Student B showed the least advancement on the Wide Range Achievement Test, Level I, with a program impact index of 1.6 shown in Table 1, page 24. His growth score was only 1.6 times greater with the intensive rehearsal method.

Tables 3 and 4, pages 29 and 30, show the program impact factor on Level I and II of the Wide Range Achievement Test. Student B's score on Level I is .597. The program impact factor tells us that Student B's growth rate on the Wide Range Achievement Test, Level I, was .597 times greater with the intensive rehearsal method exclusive of his .814 expected grade advancement based on the methods used prior to treatment.

It should be noted that Students A and F achieved inordinately high ratios on Levels I and II of the program impact index, Tables 1 and 2, pages 27 and 28, and on Levels I and II of the program impact factor, Tables 3 and 4, pages 29 and 30. These high ratios may indicate that these students are possibly underachievers and should not be classified as learning disabled. Perhaps with proper motivation these students would succeed in a regular classroom.

TABLE 3

STATISTICAL SUMMARY

LEVEL I

WIDE RANGE ACHIEVEMENT TEST

PROGRAM IMPACT FACTOR

1 Student	2 Grade Completed	3 Pre-Test Grade Equivalent	4 Average Grade Equivalent Per Year	5 Pre-Test + Average Gain	6 Post-Test Grade Equivalent	7 Treatment Gain	8 Program Impact Factor
A	11	9.0	.82	9.8	14.9	5.1	6.2
B	7	5.7	.81	6.5	7.0	.5	.6
C	8	5.5	.69	6.2	8.2	2.0	2.9
D	8	3.9	.49	4.4	5.2	.8	1.7
E	7	4.5	.64	5.1	6.3	1.2	1.8
F	9	2.4	.27	2.7	6.7	4.0	15.1
G	7	3.9	.56	4.5	5.5	1.0	1.9
H	7	3.6	.51	4.1	5.3	1.2	2.3
I	7	3.6	.51	4.1	6.1	2.0	3.9
J	8	5.5	.69	6.2	8.8	2.6	3.8
TOTALS	--	47.6	5.99	53.6	74.0	20.4	40.2
MEANS	--	4.76	.60	5.36	7.40	2.04	4.02
Average Grade Equivalent for the group		= 4.76			= 7.40	2.04 = average gain for the group	4.02 = average impact factor

TABLE 4

STATISTICAL SUMMARY

LEVEL II

WIDE RANGE ACHIEVEMENT TEST

PROGRAM IMPACT FACTOR

1 Student	2 Grade Completed	3 Pre-Test Grade Equivalent	4 Average Grade Equivalent Per Year	5 Pre-Test + Average Gain	6 Post-Test Grade Equivalent	7 Treatment Gain	8 Program Impact Factor
A	11	6.9	.63	7.5	12.3	4.7	7.6
B	7	5.3	.76	6.1	5.7	.4	-.5
C	8	6.1	.76	6.9	9.0	2.1	2.8
D	8	2.3	.29	3.4	3.3	.8	2.8
E	7	2.9	.41	3.3	4.5	1.2	2.9
F	9	2.3	.26	2.6	5.9	3.3	13.1
G	7	3.1	.44	3.5	4.9	1.4	3.1
H	7	2.9	.41	3.3	4.4	1.1	2.6
I	7	4.4	.63	5.0	5.7	.7	1.1
J	8	6.1	.76	6.9	8.0	1.1	1.5
TOTALS --		42.3	5.35		63.8	16.0	37.5
MEANS --		4.23	.54		6.4	1.6	3.75
Average Grade Equivalent for the group	=	4.23		=	6.40	1.6 = average gain for the group	3.75 = average impact factor

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

This study was conducted to determine the effect of an intensive rehearsal technique on the retention of basic arithmetic facts among male students classified as learning disabled.

The results of the study support the contention that male students who are classified as learning disabled, and are taught basic arithmetic facts with an intensive rehearsal technique, do retain a significantly higher amount of the material taught to them than they do when taught by other methods of instruction.

The data that supports this conclusion were collected at the end of the year long intervention. Student achievement exceeded by large margins that which had occurred during the years prior to the intervention.

The statistical analyses reveal that the use of the intensive rehearsal technique is effective. However, the researcher believes that Student A may have been an underachiever rather than learning disabled. A description of Student A may help the reader understand the basis of this conclusion.

Case history: Student A, as shown in the bar graphs, (see Appendix), achieved an increase of 5.9 years on the Wide Range Achievement Test Level I and 5.4 on the Wide Range Achievement Test Level II. This boy, age 17, should have been in grade 12, had completed grade 11, and pre-tested at grades 9.0 and 6.9 on Levels I and II of the Wide Range Achievement Test, respectively. He post-tested at 14.9 and

12.3 on the Wide Range Achievement Test Levels I and II. His expected grade advancement, based on his yearly progress at the time of the study, was .82 years. The extreme Wide Range Achievement Test, Level I scores showing a discrepancy between .82 years average gain prior to treatment and 5.9 years following the intervention and the Wide Range Achievement Test Level II scores of .63 years and 5.4 years suggest that this student was not learning disabled. This student was an extremely manipulative individual who supposedly sold drugs but supposedly used them sparingly, expressed himself well verbally, was not physically aggressive, and appeared comfortable in conversations with teachers and peers. He supposedly experienced an erratic home life with one or both parents drinking and missing from home from time to time.

His efforts to "squeeze by" and his derisive language toward teachers revealed his attitude toward school. He was disrespectful of the law and authority in general. He appeared to be undisciplined in all facets of life except those which provided him with what he wanted.

The organized format, consistent discipline aimed at maintaining "on task" behavior by the teacher and aide, and readily available help with assignments appeared to appeal to this student after his inital attempts at rejection.

Student A rarely had to be shown twice how to perform certain math functions, for example, equations and problem solving equations. He moved through the basic fact tests with little difficulty. Once this student became accustomed to the daily routine, he progressed very rapidly through entire math units. He appeared to thrive on the organized format, was far less manipulative and was pleasant to work with during the time of the study. He appeared to be an individual who had "fallen through the cracks" in the educational system. This student responded in a positive manner to the treatment program.

Case history: Student B, as shown in the bar graphs, (See Appendix), showed the least progress based on the Wide Range Achievement Test results. On Level I this student advanced 1.3 years but on Level II only .4 years. This boy, age 13, was in grade 8 but pre-tested at grades 5.7 and 5.3 on Levels I and II of the Wide Range Achievement Test, respectively. His expected grade advancement, based on his yearly progress prior to the time of the study was .81 and .76 on Levels I and II of the Wide Range Achievement Test.

Student B like Student A was manipulative and supposedly used drugs and alcohol frequently. He did not express himself well verbally and often did not respond to verbal cues designed to keep him on task. He did not ask for help, was generally quiet, and was passive unless provoked. He, supposedly, experienced an unstable home life, one lacking organization and discipline. He spent much time "on the street".

Prior to the study treatment this boy's attitude toward school and authority in general was very poor. His philosophy on life appeared to be one of an escape for survival and withdrawal from responsible roles. Within the context of the study this boy consistently needed more supervision and help with assignments.

During the school year he would be absent from school for days at a time. When he returned he appeared "burned out" from drugs and/or alcohol. The following year this boy entered a residential drug/alcohol rehabilitation unit.

Student B appeared to be comfortable operating with the organized format of the intensive rehearsal technique. However, he was inconsistent with story logic problems, being relatively proficient on one day and appearing not to recall basic math processes on the next. This is manifested in the inconsistency of his Wide Range Achievement Test, Levels I and II, grade levels of progress of 1.3 and .4. A residential setting where this student's drug and alcohol habits could be treated and his school work could be carefully monitored would likely provide a better profile of his skills and potential.

In summary, Student A responded to the individualized attention factor of the Intensive Rehearsal Technique in a very positive manner. He enthusiastically applied the knowledge obtained from one on one instruction to the textbook work and the matheputer. Student B did not respond well to one on one instruction, usually displaying a defensive attitude by being uncooperative and uncommunicative. He did not care much for the book work. He retreated to already learned simple skill problems on the matheputer. Even this simple work required prompting by the teacher/aide or the student would not remain on task.

Recommendations for Further Study

This research is the wellspring for the following recommendations for further research:

1. Studies employing the intensive rehearsal technique with female learning disabled students are needed. The effectiveness of the Intensive Rehearsal Technique has not been established with female learning disabled students.

2. Longitudinal studies of the retention of basic arithmetic skills among male and female learning disabled students who have been taught by the intensive rehearsal technique would be useful. Long-term studies of retention of basic arithmetic skills would provide an index of the staying power of the technique and therefore the advisability of its use.

3. Studies employing instruments other than the Wide Range Achievement Test as measures of student performance e.g. Key Math Stanford Diagnostic Math Test, which may provide more in-depth diagnostic information, are worthy of attention. Other diagnostic methods would offer the researcher more information about the specific effects of the interventions.

4. Studies involving factorial analysis of the intensive rehearsal technique to determine the contribution of each technique to the post-test performance e.g. microcomputer, Spectrum Math Series, and individualized instruction could be dealt with as a separate entity, each contributing to the sum total results. Do these techniques operate synergistically, catalytically, or in other ways? These studies could help educators select from among

the treatment alternatives.

5. Studies comparing traditional teaching techniques with the intensive rehearsal technique would be useful. These studies would help educators discern the differences between the traditional teaching technique and the intensive rehearsal method, thereby providing criteria for selecting the appropriate techniques for students with differing handicapping profiles.

APPENDIX A

SPECTRUM MATHEMATICS SERIES

I. Course Description: The development and mastery of basic Arithmetic processes (addition, subtraction, multiplication and division) and the application of these concepts to life-situations comprise the intent of this course. Heavy emphasis will be placed on the transfer of basic skills and concepts to practical problem solving tasks. Focus of the course is upon the content generally taught at the elementary and junior high level.

II. Major Content Areas:

A. Level 3

Addition and subtraction

2, 3, 4 digits, renaming

Calendar, Time, Money

Multiplication 5x9; 9x9

Multiplication 2 digit by 1 digit

Division 27 3; 45 5

Multiplication 3 digit by 1 digit

Problem solving skills via word logic problems

B. Addition and subtraction, renaming

Addition and subtraction, 3 digit and 2 digit, renaming

Addition and subtraction, 3 digit through 5 digit

Multiplication, 3 digit by 1 digit; 2 digit by 2 digit through 3 digit by 2 digit

Temperature, money

Division, basic facts

Division, 2 and 3 digit dividends, 4 and 5 digit dividends

APPENDIX A (cont'd)

Multiplication and division, checking

Measurement, weight, time, linear, capacity, perimeter

Problem solving skills via word logic problems

C. Level 5

Addition and subtraction, 2 digit through 5 digit

Multiplication, 2 digit by 1 digit through 4 digit by 3 digit

Division 2, 3, and 4 digit dividends

Measurement, liquid, linear, area

Fractional numbers, addition with common denominators; multiplication; renaming

Problem solving skills via word logic problems

D. Level 6

Addition and subtraction, of whole numbers

Multiplication and division, of whole numbers

Multiplication of fractional numbers

Addition and subtraction of fractional numbers

Division of fractional numbers

Measurement, liquid, linear, time, area, volume

Addition and subtraction, decimals

Multiplication, decimals

Division, decimals

Per Cent

Problem solving skills via word logic problems

E. Level 7

Addition, subtraction, multiplication, and division, whole numbers

APPENDIX A (cont'd)

Addition, subtraction, multiplication, and division, fractional numbers

Addition, subtraction, multiplication, and division, decimals

Ratio and proportion

Decimals, fractions, and per cent

Interest

Geometry

Perimeter and area, rectangles, triangles, circles

Volume, rectangular solids, cylinders, cones and pyramids

Problem solving skills via word logic problems

F. Level 8

Addition, subtraction, multiplication and division

Equations

Equations to solve problems

Ratio, proportion and per cent

Simple and compound interest

Geometry

Similar triangles, and the Pythagorean theorem

Perimeter, area, and volume

Measurement and approximation

Graphs

Algebra

Problem solving skills via word logic problems

APPENDIX B

SUMMARY FOR CORRELATED T

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         SUMMARY FOR CORRELATED T


X = WRAT LEVEL I POSTTEST
Y = WRAT LEVEL I PRETEST


MEAN 1 = 7.4  S.D.= 2.89175072  S.E.M.= .91445187
MEAN 2 = 4.76  S.D.= 1.81854643  S.E.M.= .575074874


THE VALUE OF THE T-STATISTIC IS

                5.58578151

DF = 10


**************************************
RAW DATA USED IN THIS T-TEST


DATA FROM GROUP X
=================
14.9
7
8.2
5.2
6.3
6.7
5.5
5.3
6.1
8.8
DATA FROM GROUP Y
=================
9
5.7
5.5
3.9
4.5
2.4
3.9
3.6
3.6
5.5
```

APPENDIX C

SUMMARY FOR CORRELATED T

****

SUMMARY FOR CORRELATED T

X = WRAT LEVEL II POSTTEST
Y = WRAT LEVEL II PRETEST

MEAN 1 = 6.38   S.D.= 2.67116288   S.E.M.= .844695869
MEAN 2 = 4.23   S.D.= 1.74995238   S.E.M.= .553383532

THE VALUE OF THE T-STATISTIC IS

4.67624634

DF = 10

****
RAW DATA USED IN THIS T-TEST

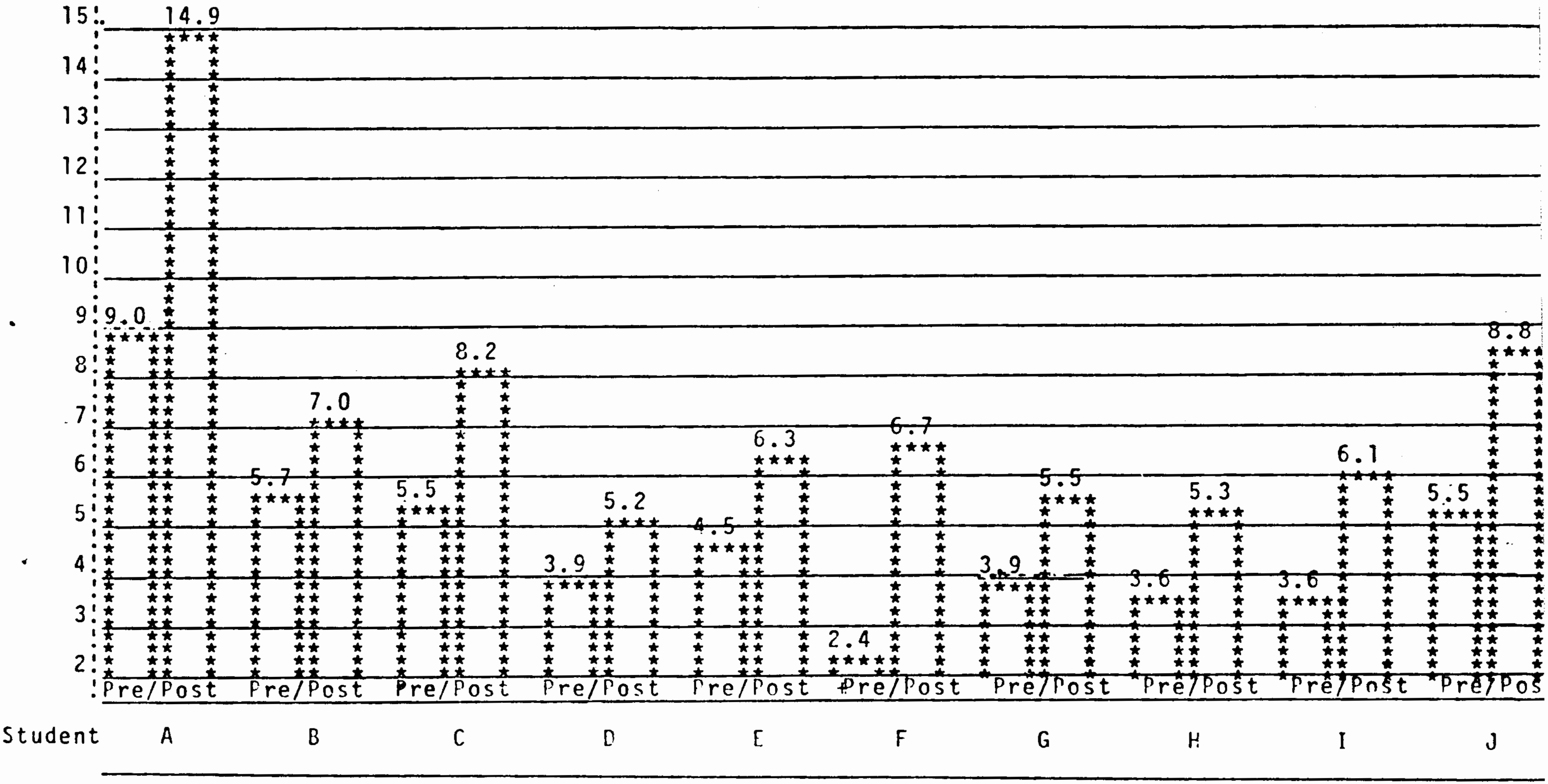
DATA FROM GROUP X
================
12.3
5.7
9
3.4
4.5
5.9
4.9
4.4
5.7
8
DATA FROM GROUP Y
================
6.9
5.3
6.1
2.3
2.9
2.3
3.1
2.9
4.4
6.1

APPENDIX D

Wide Range Achievement Test

Grade Range Level I

Comparison of Pre/Post-Test Data

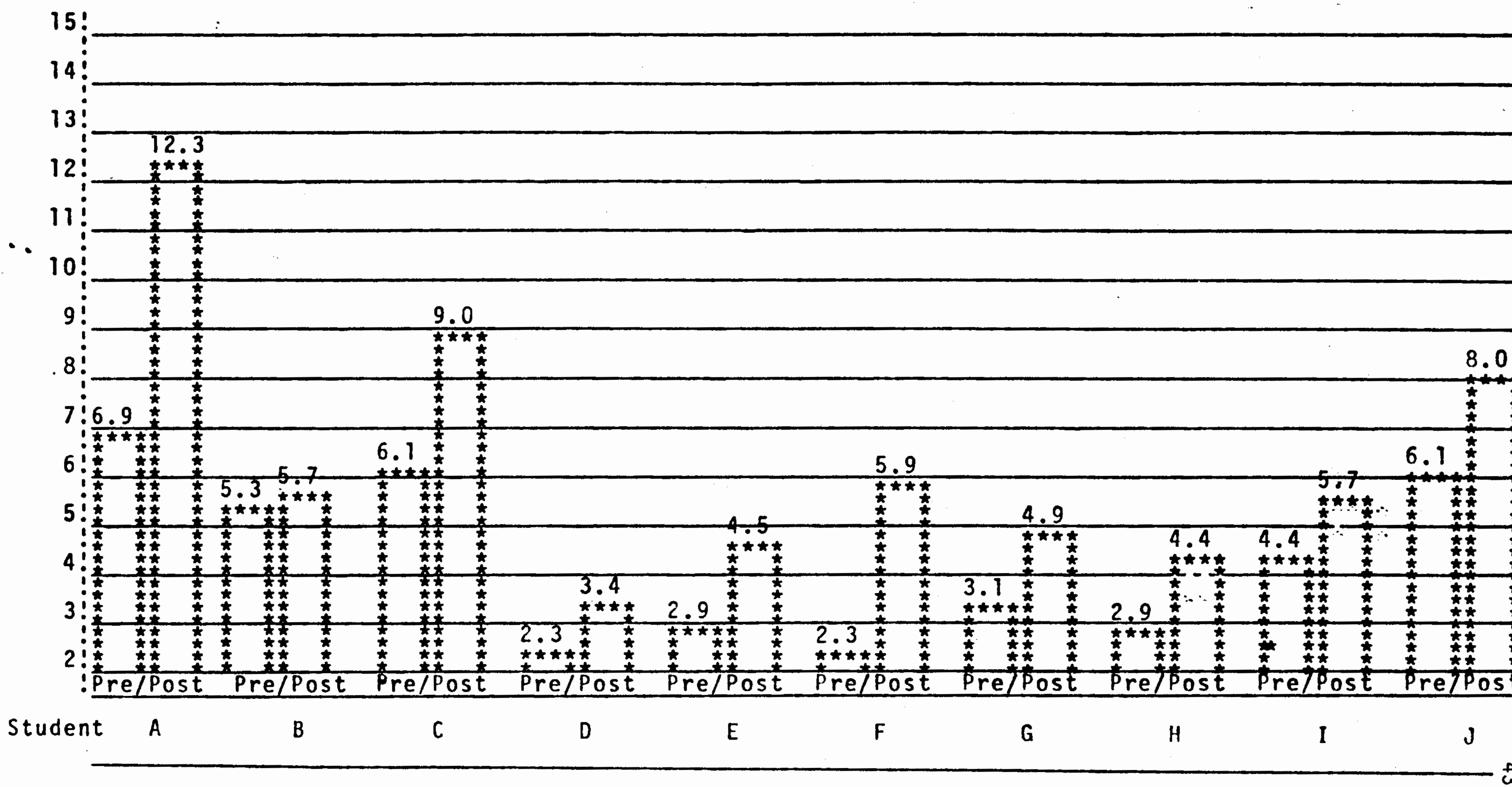


APPENDIX E

Wide Range Achievement Test

Grade Range Level II

Comparison of Pre/Post-Test Data



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