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An Experimental Study of Two Methods of Teaching Mathematics in Second Grade

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AN EXPERIMENTAL STUDY OF TWO METHODS OF TEACHING MATHEMATICS IN SECOND GRADE

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INTRODUCTION

Elementary mathematics is in the daily lives of both children and adults. The modern technocracy in which we live demands that each citizen attain mathematical literacy if he is to carry out his responsibilities and make use of the many opportunities available to him (2:49). All phases of life will undoubtedly be more dependent on mathematics in the future than they are today.

Logically then, arithmetic should be meaningful and of much interest to a child. The fact that this is not true in a large percentage of cases indicates that something is lacking in the child's early arithmetical learning experiences and that these experiences should be improved.

Children vary in their ability to learn arithmetic just as they vary in their ability to learn other subjects, and it has been established they learn arithmetic most readily through meaningful teaching on their own ability level (32:136).

This raises one of the most challenging issues facing teachers of elementary mathematics today - that of meeting the wide range of abilities found in the average classroom.

To add another item to an already overcrowded day is indeed a task of great proportion. But something can be

done about individual differences. It is a sign of forward thinking to experiment with an individualized program, keeping it flexible so that alterations may be made if and when necessary (44:199).

It is recognized that this type of program will require much teacher planning time and a departure from traditional methods which hold a certain amount of security into an experimental, untried area. But if approached thoughtfully and enthusiastically "the task of teaching children to be at home in a world of numbers can be an exciting challenge" (30:5).

THE PROBLEM

Statement of the Problem

It was the purpose of this study to compare two methods of teaching arithmetic in the second grade, an individualized method and a one group method, to determine if there were any differences in the achievement made by the two groups.

The null hypothesis tested was that there was no statistical difference between the achievement made by pupils in an individualized arithmetic program and in a one group arithmetic program.

Importance of Study

Many important studies have shown that arithmetic is more easily learned when what is being taught is made

meaningful and significant to the pupils, and when the instruction is so organized that their individual differences in rates of growth are provided for (3:2). The child who is permitted to practice at his own rate on his own ability level for a given topic should make more progress than a child who must work at a pace which has been arbitrarily set (36:321).

The formation of a method of teaching which would create and hold the pupils' interest in such a vital subject as arithmetic is of prime importance. Such a program must of necessity be very flexible for there is no absolute way to meet all the problems faced by a teacher in meeting these individual differences (16:81).

Since authorities in the field of mathematics believe that ability in this field is below what it should be in many instances, and that competence can be increased through meeting the individual differences found in children, it was the plan of the writer to try to determine an individualized program which would help each child in the room meet the arithmetic requirements set up in a school district for the second grade.

Limitations of the Study

The sample was limited to the pupils in two second grade classrooms in Richland, Washington. The experiment

was performed during one quarter of a standard school year.

No attempts were made to control the variances in socio-economic status, health, home background, or emotional background of the sample. It was recognized that any of these factors might have affected the learning of the children.

The two groups were set up prior to the time of the experiment, thus, were not matched as to intelligence. However, scores made on Otis Quick Scoring Intelligence Tests showed that the two groups were very comparable.

The two classes were taught by two different teachers. The control teacher was chosen by the principal as being the most nearly like the experimental teacher in teaching ability.

Definition of Terms

One group method. The entire classroom is taught in one group, with the teacher giving assistance whenever possible to pupils having difficulty.

Traditional method of teaching. The teacher does the telling, children memorize the facts, and little emphasis is placed on understanding concepts.

Fast learners. These are the pupils who are in the upper one-fourth of the class in arithmetic achievement, and require very little explanation prior to grasping new concepts in arithmetic, thus working at a faster rate than other pupils in the classroom.

Slow learners. These are the pupils for whom the grasping of new arithmetic concepts is very difficult. They must work for a longer period of time with concrete materials, and at a much slower pace than other pupils. They are in the lower one-fourth of the class in arithmetic achievement.

Horizontal enrichment. This is a process of broadening the pupils' knowledge and understanding of a particular process by giving "in depth" study with such materials as flash cards, puzzles, workbooks, games, job cards, and self-help pages.

Individualized instruction. This method of instruction "includes all the procedures involved in the adaption of instruction to the particular requirements of the individual pupils in the class. Individualized instruction does not mean necessarily that the children are instructed one at a time.....When two or more children share a need for the same learning experience, group instruction often insures the most economical use of teaching time" (22:81-82).

Individual differences. "The variation or deviation among individuals in regard to a single characteristic or a number of characteristics" (20:172).

Organization of Thesis

The remaining chapters of this report have been organized in the following manner:

Chapter II Review of the Literature

Chapter III Procedures

Chapter IV Results

Chapter V Summary and Conclusions

CHAPTER II

REVIEW OF THE LITERATURE

It is the purpose of this chapter to review the various methods that have been used to meet the educational need of the youth of our country. A brief overview of the early school practices will be followed by a review of some of the methods that have been tried in an attempt to more nearly meet the problems of educating large numbers of students with their varying abilities and skills.

The last part of the chapter will be concerned with the importance of individualizing instruction in general and of arithmetic in particular, and a review of some of the programs that have been or are being tried to individualize instruction in arithmetic at the present time.

Historical Background of Schools in America

The earliest schools during the colonial period were held in the homes and were essentially non-graded. They were tutorial in design - one teacher, one room, one group, and acceleration or failure were unknown. Each pupil progressed at his own individual rate (27:180). The schools had the purpose of teaching children how to read, spell, and write.

This form of teaching largely ceased to exist as the

number of children attending school increased. Since one teacher could not handle the larger groups of students, a system of monitors was started in which advanced pupils worked with small groups of children after they had recited their own lessons. This led to the Lancastrian system of instruction which became very popular in the latter part of the eighteenth century and early part of the nineteenth century. However, the ever growing number of children attending school, the growth of subjects to be taught, and the lack of capable assistants and personnel to manage the schools caused a realization that some other form of school organization would be necessary (18:49f).

In 1848 the Quincy Grammar School in Boston was created. This was the beginning of the graded school system which is still the basic style of school structure in America. It was a lock step system with one teacher for one grade, certain standard criteria for material to be taught on a particular grade level, and pupils placed in catagorized groups to progress from one grade to another each year. "At the time of its design it conformed to the then prevalent conceptions of child development and education was a schooling process" (27:179).

After a number of years, objections began to be voiced about the integrity and merit of this method of teaching.

Large numbers of children were failing or dropping out of school. Brighter students were bored and the slower learning children were falling even further behind (18:52).

Changes That Were Introduced

In the latter part of the nineteenth century many plans were introduced to try to correct the faults that were found with the graded plan. Although none of these programs are still in effect, among them are found some ideas that are in use. Following are some of the best known plans:

1. The Saint Louis Plan created a quarterly promotion plan to try to break the lock-step plan.
2. The Pueblo Plan used small groups to try to individualize education.
3. The Cambridge Plan permitted the gifted child to progress at a faster pace.
4. The Elizabeth Plan provided for promotion whatever time of the year a child was ready.
5. The Portland, Oregon Plan, like the Cambridge Plan, made provision for the brighter pupils to move ahead on a double track system.
6. The North Denver Plan set minimum requirements for all pupils but allowed faster achieving pupils to move ahead more rapidly.
7. The Santa Barbara Plan provided for three groups in a class with material in the amount and on the level at which they could best achieve (18:53-54).

The twentieth century, with its changing needs, has brought many other innovations which have been set up to more nearly meet the individual educational needs of the youth of today.

The following, like the plans mentioned before, were some of the more prominent ones.

The Platoon System was a plan of organization and not a method of teaching. Children were divided into two groups and while one group was having instruction another group was having some activity in another subject. Its main purpose was to make more efficient use of the school plant.

The Gary Plan was very similar to the Platoon System. All the children from kindergarten to post graduates were instructed in the same building. Instruction was organized on a year-round basis. The regular school year was 192 days, seven hours a day. The summer session was eight weeks, six hours daily. On Saturdays there were classes for three hours in the morning for thirty-four mornings (7:40-42).

The Dalton Plan first introduced in a Dalton, Massachusetts, High School had as its purpose socialization of school to keep it from becoming mechanical. A job sheet unit plan was made with each child, and he could move along at his own rate of accomplishment (39:83-93).

The Winnetka Plan, started by Carlton Washburne, was another innovation to let children progress at their own rate in academic subject matter and to provide for a wide range of group and creative activities. It was devised to eliminate repetition of grades, to give each child a better mastery of knowledge and skill subjects, and to give

adequate provision for self-expression and socialization (55:214).

The XYZ Plan in Detroit placed children in groups according to ability testing and teacher judgment. A differentiated course of study was presented - a regular course for Y's, enriched course for X's, and a simplified course for Z's. Each group covered the same basic material, but both differentiated courses of study and teaching methods were used (9:45).

There are many other plans which have been attempted to meet the educational needs of the individual child as it has become more apparent that the graded school plan with its mythical "average" has not fulfilled its hoped for mission (18:55-59). Only parts of these plans are in operation today, for no effective method has yet been found to completely replace the graded system with all its recognized faults.

Importance of Individualizing Instruction

With the acknowledgment by the early forefathers of the country that to have an effective democracy there must be an informed people, began one of the greatest social experiments of all times - the American free public education system. The fact that it is for all people embodies its greatest strength and, also, its most difficult problems.

One of the major difficulties is to provide a quality education for all children with their varying abilities, needs, and emotional problems. While all individuals should be considered to have equal value, they do not all have the same capacity for learning, nor for performance. They are not the same in size, physiological processes, motor capacities, intelligence, sensory and perceptual sensitivity, interests, attitudes, background, nor personality traits (53:5). This does not imply that there are not common skills, knowledge, and attitudes that all children should be exposed to, but it does say "that all children cannot learn all things in a standard way and at the same time" (38:59).

Buswell says that in our American schools an attempt is made to teach all the children and in so doing, all the children are not taught well (19:16). This is a serious thought and one that demands action be taken on the part of each teacher, for "one of the basic tenents implied in our democratic way of life is that each individual, regardless of background, should be given the opportunity to develop to his full potential" (45:52).

There are in our classrooms today many children who would have dropped out of school in the early grades twenty or thirty years ago. If their interests are not met in some way and their abilities developed, they may well become part of the problem of tomorrow, for if education does not

meet a child's needs he will not respond, and if he does not try he will not learn (58:72). In the highly technological society in which our youth will live, there will be little place for the dropout and the uneducated. So it is very apparent that one of the ever present problems of human education is adapting the material to be learned to the level and ability of each child. Witty says that, "one of the greatest shortcomings of our school systems today is their failure to recognize and conserve human ability" (57:359).

While the primary task of the school is the intellectual development of students, it is very important to make provision for the differences in human growth and development. Each child has his own way of developing and learning (25:9). Since the growth and development patterns both physically and mentally differ from child to child, it logically follows that we cannot expect either the same amount or quality of work from each child (41:28).

Psychologists agree that the "pupil learns only his own responses," and that emphasis should be placed upon his individual knowledge, needs, capacities, interests, and limitations (58:63).

In the average first grade room there will be a range in differences in mental age from approximately four years six months to eight years six months, and as the pupils

progress from year to year the span widens. IQ's may range from 60 to 130 (29:19). Thus it is easily seen that some pupils will already know or quickly grasp the material and become bored. Others will be unable to grasp what is presented and be frustrated if the entire class is kept on the same level.

This does not imply that providing for individual differences is to have each child working completely alone at all times. Working together as a group will always have merit, not just to save time, but also for pupils to learn to give and take and to work together. They need to build a group consciousness, an "esprit de corps", which makes each child strive to do his best. By interacting with other members of the class he forms a basis for his own self evaluation (10:5).

The belief that children should enjoy learning and that it is the teacher's duty to help them enjoy it is one of the distinguishing differences between American teachers and teachers abroad. "We feel it is our duty to teach all children; that if the child does not learn, it is less his fault than ours" (47:30).

With this philosophy, thoughtful teachers are continually searching for ways to meet the individual differences found in their classrooms, for it is "only when each pupil is taken where he is and challenged to go as far as he can go,

will his achievement and the total achievement of the class approach the maximum" (10:5).

Need for Individualization of Mathematics

Mathematics was not even mentioned in the Massachusetts Education Act of 1647 which ordered the establishment of schools for reading and writing. Since these first schools were established to preserve the religious practices of the time, this is not surprising.

The demand for knowledge of mathematics came from the growth of commerce in New England in the late eighteenth and early nineteenth centuries. As commerce and industry grew in importance, so did the schools. The purpose of mathematics was to "teach pupils how to do the kind of computation that the times demanded" (46:3). One of the early 1800 textbooks, A New Complete System of Arithmetic, had only a little more than three pages devoted to addition and about the same amount of space given to subtraction. Multiplication was considered more important than the other two processes.

The mathematics program became more important during the early part of the twentieth century. Some of the factors which influenced this growth were the compulsory school attendance law, the progressive education movement, which put emphasis on child interest and needs, the child study

movement, and the development and use of psychological and achievement tests (46:5).

This increased emphasis on education, combined with an unprecedented technological growth in our nation has undoubtedly given great impetus to the expansion of and interest in the field of mathematics, for "more mathematics have been created in the past fifty years than in all the centuries before the beginning of the twentieth century" (33:1).

This growth along with the amazing developments in the field of nuclear physics and rocketry, space exploration, and invention of the electronic computer, has created a demand for trained personnel in the field of mathematics that revealed a serious shortage of such personnel (54:2).

In view of these facts it would appear that pupils would be more highly motivated to study and learn mathematics and that it would be one of the more popular subjects in school. This is not true. Arithmetic is more misunderstood by the children who finish elementary school than any other subject that is taught, and causes more school failures above the first grade than any other subject in the elementary school. Since this is an era of rapid scientific and technological growth and a time of ever present threat to the national welfare, society can scarcely afford to waste this potential talent (13:4).

Young children usually like arithmetic, but as they progress through school what was once pleasure becomes a source of frustration and dislike for too many of them.

> Something went wrong with the process of learning....Maybe the teacher had an inadequate understanding of arithmetic herself; maybe the child had been told that arithmetic was very hard and believed this so firmly that it became true; maybe there were too many children for one teacher to teach satisfactorily; maybe the pupil was confused by too rapid presentation of number facts and relationships; maybe lack of success led to fear of failure, which in turn became a guarantee of failure (49:3).

Whatever may have been the reason, the fact that many children dislike arithmetic is unfortunate for there will be continual frustrations for the mathematically illiterate in our modern era (48:XIII).

While there are other contributing factors, authorities are agreed that something is wrong with arithmetic in the child's school experience and needs to be improved (49:9). Brownell states there is much need for improvement in arithmetic, and instead of continuing to use the same teaching methods that created the learning deficiency, educators should completely restructure their materials and methods of teaching for the demands of modern living make arithmetic competence one of the real imperatives (17:4).

A program of arithmetic instruction should be presented in such a manner that pupils discover the principles and facts just as they would in a science laboratory. To present facts

and have them recited back by the class is not an effective method of meaningful arithmetic instruction (24:5).

While there are many reasons why arithmetic has been disliked by many pupils, one of the outstanding ones is the lack of provision for individual differences. "Individual differences among children show up strikingly in arithmetic. What some can learn with ease, others learn with difficulty, and still others do not seem to learn at all" (37:204).

Weaver believes that children should be grouped for instruction on a "levels for learning" basis. This procedure of providing for the differences found in each child has been neglected, and to continue to do so only means inadequate instruction for them.

Because children learn at different rates, materials should be provided that will enable a child to progress at his own rate and to work independently in his study of those skills.

> Our increased attention to this technique truly is a promising trend in our attempts to make more adequate provision for individual differences through more effective differentiated instruction (19:51).

People vary in their ability to learn arithmetic just as they vary in their ability to learn other subjects, but all children whose ability permits them to learn to read can develop reasonable competence in arithmetic. A child does not have to have a special aptitude for arithmetic to have

a reasonable degree of success with elementary school arithmetic and enjoy doing it.

It is very important that arithmetic be taught in a sequential manner for short cuts do not exist in this subject. The child should have a logical mental organization of the arithmetic knowledge he does have so that as new concepts are introduced he can see how each idea fits into the pattern he already knows, for there must be no omissions of content. "Arithmetic has a logical structure which makes sense to the person who sees that structure. Arithmetic...serves its purpose only when it becomes a part of the learner" (49:19). Content that is not learned before moving to another area in arithmetic is a serious handicap to a child. This does not imply that all children will have the same proficiency in each area, but each child should have a basic understanding of the processes involved.

There are two major objectives in the modern arithmetic program. One is to develop the ability to perform various number skills along with the understanding of why and how these processes are being used, and the other is to provide many rich and varied learning experiences which will prepare the pupil to effectively apply these processes in situations outside the classroom. By being provided with rich and varied learning experiences, children are encouraged to work independently, they are given the opportunity to discover and

develop more interest in the field of mathematics, they are challenged to work at their highest level of operation, and the more able children acquire more knowledge and develop broader skills than children of average ability (3:80).

Understanding creates a certain degree of competence; competence creates appreciation; appreciation creates enjoyment; and when a process is enjoyed a child can work comfortably within the limits of his potential (8:13).

Differing methods of individualizing arithmetic have been and are being tried to see that each pupil is actively involved in the learning of this important subject. Some teachers have advocated complete individualization with each child working on his own, others hold that grouping in two or more groups might be the more advantageous, while still others consider a combination of whole class and small group organization to have more merit (16:81). "Whether the children should work individually, in small groups, or as a class depends upon the ages of the children, the differences in their abilities, and the nature of the activity" (28:48). There is no "absolute" way to meet all the problems that are faced by a teacher in meeting these individual differences.

Whatever method is decided upon, the teacher should consider the intellectual ability of his pupils before he begins to group or prepare for individual instruction. It is necessary that maturation, social growth, emotional readiness,

as well as intelligence be considered. "Teachers must select the highest development for each pupil in her class and must up grade pupils individually toward increasingly higher levels of performance" (8:13).

As the research on arithmetic is considered, it is evident that there has always been a striving for a balanced program that considered the needs of society, of subject matter, and the child. "The striving for a balanced arithmetic program continues to the present" (5:387).

Individualized Programs in Arithmetic

Following are descriptions of some of the programs in effect today. The list is far from complete, but these are representative of the work being done.

Frank Searight began his program of individualizing arithmetic instruction by preparing a large chart with the children's names listed vertically and the pages from the textbook he felt most important listed horizontally across the top. This was designed to allow the children to progress at their own rate through the book. Answers were checked in one of the answer books available, corrected, and help given if needed.

As soon as one assignment was completed the child proceeded to the next. As a child or small group needed instruction in a new concept the teacher worked with them

until they were able to understand and proceed alone. During the arithmetic period the children were busy, so the teacher was free to work with individuals who needed assistance. Homework was assigned on the basis of individual needs.

The span of abilities increased as more able pupils moved rapidly ahead, but the slower learners made steady progress.

This program was not completely individualized for most of the children did the same kind of work, even though it was done at differing rates, but it was the beginning of one (44:199-200).

In Oak Hill, Florida, an individualized arithmetic program was conducted on the sixth grade level. Because of the wide range of abilities, they believed that an effective job of teaching could not be done using the one group method of teaching arithmetic. A workbook, intended as an arithmetic refresher course, containing material from third grade level to elementary algebra and geometry, was used as a text.

After a thorough review of basic skills children were given a diagnostic test. This, together with the scores from county-wide standard achievement tests, formed the basis for assignment to specific sections of the workbook.

Unlined 3" x 6" index cards were ruled with enough space to keep an individual record of work for a month.

At least three times a week each child had a conference with the teacher, depending on the class size and the amount of assistance he required.

Although he could set his own pace, each pupil was required to complete a minimum amount of work each day. Answer sheets were provided so that children would check their own work. After errors were corrected, the teacher checked the paper "F", indicating finished. This eliminated teacher time in grading homework assignments. Work was done on notebook paper and workbook pages were saved to be used as review sheets.

During each six-week period, four tests were taken by each child, and reviews followed each test so that pupils would not forget the previous material.

The Elementary California Achievement Test Battery was given on a county-wide basis, September 23, 1958. At that time pupils in this room ranged from 3.8 to 7.6 in total arithmetic scores, with the median 5.9. They were retested May 1, 1959, and their scores ranged from 5.0 to 10.5, with a median of 7.3, a gain of 1.4 in seven months (45:88).

A third program of individualized instruction is being conducted at Oakleaf School, Baldwin-Whitehall, Pennsylvania.

Records are kept of the individual progress of each student in the school by school aids. This information is

collected for use in researching the results of the school's methods.

Instruction seems rather chaotic when first observed, for children are free to move about and may leave the classroom altogether for new materials. This would, obviously, be more noisy than a traditional classroom.

By the use of IPI materials which consists of tapes, worksheets, and records aimed at self-instruction, and built-in tests which help the pupil identify if he requires more study or can move ahead, the children are being helped to find their own individual direction through the traditional curriculum. Each child works with the material on his own. The teacher assists in correcting his work, checks his progress and assigns new work as he goes along. If several children are having difficulty the teacher may form a small group to give them direct instruction. Two "floating-in-school" teachers are available to lend assistance or give remedial help.

This is a program where children can go their own way, in their own time, and work below frustration level. There are problems, but they are working to eliminate them (51:80f).

There are other individualized programs in progress, but the above are representative of the efforts that are being made to better meet the educational needs of the youth of today.

A survey of the history of education shows that our schools have served the children of the nation well. The changing times places an even heavier responsibility on the school, the teacher, and the pupil, but forward looking educators are working steadily to meet these challenges.

It cannot be predicted what type of knowledge will be needed by the students being taught today in the world in which they will live as adults, but this is known, "there will be a much greater dependence on mathematics in the future than in the world of today" (48:XVI). The teacher should strive to teach this important subject in a manner that will create understanding, interest, and real enjoyment on a level that will be adequate for the future, for "real mathematics is clean and beautiful. It is fun to teach and fun to learn" (41:33).

Summary

The literature pertaining to methods which have been used to meet the educational needs of American youth from early historical times to the present day has been reviewed in this chapter.

As conditions in the schools changed and there were indications that the prevailing methods of instruction were not meeting the desired ends, experimental programs were put into practice to attempt to more nearly meet these goals.

Programs which were representative of these attempts were reviewed.

The need for individualization of instruction, particularly in the field of mathematics, was shown.

The last part of the chapter was concerned with the programs of individualized instruction in progress at the present time.

CHAPTER III

PROCEDURES

Procedures

The purpose of this study was to determine if there could be a more effective method of meeting individual needs of children in the field of mathematics than those traditionally used.

To determine if there would be a statistical difference between the two methods, an experimental program was devised using two second grade classroom groups from the same school building, one to be an experimental group and the other a control group.

The classrooms were set up at the beginning of the school year with a hetrogeneous mixture of abilities, and no change could be made in the existing groups without causing numerous problems. No attempt was made, therefore, to equate the groups as to intelligence. However, Otis Quick Scoring Mental Ability Tests, given to determine how nearly the groups were equated, showed they were very comparable. The scores ranged from 135 to 93 with a median of 116 in the experimental group, and from 140 to 84 with a median of 118 in the control group. The intelligence quotients are listed in Table II in Appendix A.

Early in January the arithmetic section of Metropolitan Achievement Tests, Form B, was given to both groups as a

pretest to determine the level of mathematical competency of the pupils. Otis Quick Scoring Mental Ability Tests were also given at this time. No further comparisions were made of the two groups until the end of the experimental period.

The control teacher was chosen by the principal as being very comparable to the experimental teacher, ability wise, based on his knowledge of the classroom performance of these two teachers over several years observation. Each teacher was to teach arithmetic approximately the same amount of time each day. The average length of the daily instructional period was thirty minutes.

The control class was taught in one group. The teacher gave individual assistance whenever possible to pupils who were having difficulty.

The pupils in the experimental class were divided into three groups partly on the basis of the scores on the Metropolitan Achievement Tests, but mainly on demonstrated ability and interest in mathematics. These groups were very flexible, and while a few pupils remained in one group the entire time, there was considerable movement among them. The changes were from slow to average, average to slow, average to high, and high to average. No child moved from the slow working group to the high group. A lengthy absence due to illness caused one boy to drop from the high to the low group, but before the end of the school year he was

again working with the high group. Many pupils changed groups several times.

Before the experiment began, the experimental class worked out a set of conduct rules and regulations and decided on the consequences of not following these established regulations. While there were some infractions of those rules, the majority of the pupils complied with the regulations throughout the year. There was of necessity more movement and noise than when instruction had been given in one group, but most of the time there was purpose in the movement. This does not suggest complete confusion and disorder. "At the sacrifice of a little orderliness, a great deal more can be accomplished" (27:280).

Procedures for getting out and putting away materials, passing papers and general housekeeping rules that had been observed throughout the year were re-emphasized at this time.

Folders were made from butcher paper, folded and stapled in the form of a large envelope, in which the pupils filed their checked work. Once complete, a unit was taken home and new folders were made during art periods. The folders were fastened to the front of the children's desks with masking tape.

Much pre-planning by the teacher was necessary. These plans were continually evaluated, changed and re-evaluated to determine if they were meeting the desired goals. This

was a time of much learning, introspection, and re-evaluation of the personal philosophy of teaching by the teacher.

The great majority of ideas for setting up the program and for the methods, materials, job cards, et cetera, were not original. The basic plan of the program was presented in a class taken by the writer in individualizing instruction taught by Miss Jettye Fern Grant at Central Washington State College in the summer of 1964. Many of the ideas for materials have been collected through the years from other teachers, various magazines and books, and for these no definite source can be credited.

The teacher introduced each new concept to the entire group. This was always done in the most meaningful manner that could be devised using concrete materials. The entire group worked on this new concept until some of the pupils felt competent to work alone. These pupils left the group to work at a table while the teacher continued to work with the rest of the group. As more pupils began to work independently, the teacher continued to work with pupils who were having difficulty, using concrete materials, presenting the concept in various ways so these children might understand.

The teacher did not work with the same group each day after some measure of competence was obtained by most of the pupils, but some time was spent with each group at least every third day. The faster working pupils often helped.

other pupils and were sometimes very successful in clarifying difficult problems for them.

At times there would be only two or three pupils in a group, since the children, upon understanding the particular process on which they were working, left the group to complete the assignment at their own speed. They could then work with the next higher group, and the stigma associated with always having to remain in one group was eliminated. Since they knew they could leave a group as soon as they understood the process, pupils voluntarily came to the table where slower learning children were working if they became confused on a problem they were trying to solve.

The entire group worked on the same arithmetical concept, with faster working pupils given in-depth work, until the teacher was satisfied that even the slower learning pupils had gained an understanding of the basic process involved. Mastery was checked by teacher constructed tests or workbook pages saved for this purpose.

The textbook used was Elementary School Mathematics, Book 2, Addison-Wesley Publishing Company, 1963, a workbook type text. Pages could be torn from the book to be saved and used as short, evaluative tests. The book was planned in units with several pages in each unit. This allowed the pupils to proceed at their own rate of speed until they came to the end of the unit. If they reached a page they

did not understand, they might ask the teacher or a friend for assistance. If the teacher were too busy with another group to stop at the particular time a child needed help, and no one else could give the needed assistance, the pupil worked with job cards, games, flash cards, worksheets or any mathematical materials available in the room until the teacher was free to help.

There were listening sets in the room, a tape recorder, and a record player. Lessons for different groups were regularly recorded by the teacher. When the group using the tape had completed the assignment, they returned to the headphones to check their work. They were to correct any mistakes before the pages were placed in their folders.

Story problems were put on tape for pupils having difficulty in reading. This solved the problem of having to ask for pronunciation of unknown words. They could read along on the pages of story problems as they listened with the headphones. All the pupils were taught how to operate the tape recorder and this freed the teacher to work with another group while still directing this part of the class.

Phonograph records were used to give practice in addition facts. Thirty addition facts with sums from zero to ten on one record, and from ten to twenty on another were given at slow, average, and fast speeds. The pupils wrote only the answers on dittoed sheets already numbered by the teacher.

This eliminated time lost waiting for pupils to number papers on which to write answers. If he did not know the answer, the child left the space blank and went on to the next problem so that he would not fall behind. As pupils felt capable they could try a faster speed, using the headphones to keep from disturbing the other class members. Since the scores on these practice sheets were not recorded by the teacher, pupils would often do this. The pupil saved the papers, if he wished, as a record for himself.

Once every two weeks, the phonograph records were used by the entire group, papers were exchanged and graded. These scores were recorded on individual sheets of graph paper so each child could see his own progress. The teacher kept these charts and returned them each time to the pupil. This was an excellent time for an extra word of encouragement or praise.

There were subtraction records with this set but since the terminology was different from that regularly used in the class, only some of the faster working pupils used them. Those pupils considered being capable of understanding and working the record problems a challenge and enjoyed doing them. No account was ever kept of this progress.

Five minute tests of either addition or subtraction facts were given every week. These papers were exchanged and corrected by the pupils. A record was kept on two other

sheets of graph paper, one for addition, the other for subtraction, again for the purpose of letting the child see his own progress. No comparision was made with other pupils. The child competed only with himself. The tests were constructed by the teacher using the facts covered by the class. The time for taking the tests was gradually shortened until they were using only one minute to complete the problems. Not all of the pupils could finish the test within the allotted time nor were they expected to, but since they were competing only with themselves they could see the progress they were making. Examples of the tests are found in Appendix B.

A few minutes were taken at the beginning of each class period to explain the material with which each group would be working. The pupils knew that they had to complete the work started the previous day before beginning a new lesson. Worksheets for the different groups were marked in the corner with a red, blue, or green crayon.

A typical day's arithmetic period would be similar to the following plan. A child from Group I would be passing the worksheets to his group while the teacher was explaining the work for the day to Group II. Group III would take pencils and workbooks to the listening stations where their lesson for the day was on tape. The teacher would then work with Group I until they understood the material to be

covered and was then free to give individual assistance wherever it was needed until the end of the class period.

As the pupils completed the work for the day they checked their work with a friend. If their answers differed, they reworked the problem to find the mistake and could always check with the teacher if they were unable to find the correct answer together. Worksheets were filed in their folders after they were completed. Examples of the worksheets are filed in Appendix B.

When pupils completed their work, they found a variety of materials available for their free work time. Each group was assigned work that was within their ability to complete, so that each child could have some free time to work with materials other than regularly assigned lessons.

Copies of old worksheets were kept in a wire basket in the room. Pupils could work these and check their answers with a check sheet that was left with each set. If two pupils were working on the same sheet they could check their answers together.

Concrete and manulipulative materials were kept on shelves near the back of the room and were available for use whenever needed. Games were also kept there and pupils were free to use those whenever their assigned work was completed.

Much use was made of job cards for independent work. Those cards were marked red, blue, and green to represent different levels of difficulty. A child was free to choose any card he wished. In the beginning many of the pupils would try the most difficult cards, but since those papers had to be corrected, they soon chose cards within their ability to complete. The pupils were familiar with the mechanics of completing job cards since they had been using them most of the year in the reading program. As the papers for the cards were completed they were put in a basket on the teacher's desk to be checked. Incorrect papers were returned for correction. A record was kept on 5" x 8" cards of all the job cards correctly completed. Those cards were filed alphabetically by the child's first name in an indexed file card box.

Several sets of both addition and subtraction flash cards were available. Pupils could work singly or in pairs, the only requirement being that they work quietly enough so the rest of the pupils could carry on their work.

The teacher had made 12 inch by 12 inch individual chalkboards from plywood which were used in many ways. They were used when a new concept was introduced. Errors could easily be erased and corrected. They were also used for solving problems when doing independent work. A number line was put across the top of the boards with a felt-tip pen.

Each pupil brought a plastic foam sponge to use as an eraser. These, along with chalk supplied by the school, were kept in a small plastic bag in the child's desk. The chalkboards were kept in a small closet and were available for the children's use at any time.

Masking tape was placed on the floor to make a large number line in the front of the room. The pupils could "walk out" problems.

Pages were taken from other workbook series, placed inside plastic folders and pupils could write answers with grease pencils on the folder. Answers could be checked by using the teacher's guide.

Some of the pupils wrote original story problems which other pupils would attempt to solve. This practice was a good learning situation, both for the pupils writing the problems and those solving them.

It was the writer's intent that a diversity of materials be available so that each pupil might find something which would be challenging enough to stimulate learning for him.

CHAPTER IV

RESULTS

During the last week of March, Form A of the Metropolitan Achievement Tests was given to all of the elementary school pupils. The arithmetic section of this test was used as a post-test for the study. The difference between the pre-test and post-test scores was completed for each pupil. The mean gain was completed for both groups, and the collected data was analyzed through the application of a t test to determine any statistical difference between the two groups. Statistical findings were reported at the .05 level of confidence. Complete data for the two groups can be found in Table I.

TABLE I

RESULTS OF STATISTICAL ANALYSIS

	N	$\bar{X}$	S^2	t	Necessary t at .05 level
Control Group	28	7.71	21.27		
				1.77	2.00
Experimental Group	28	10.46	43.70		

As can be seen in Table I, the results of the analysis showed there was no statistical difference in the two groups at the .05 level of confidence. A t value of 2.00 was required and a t value of only 1.77 was obtained.

With the lack of a statistically significant difference, it may be concluded that there is no apparent advantage of an individualized method of teaching arithmetic over a one-group method, and therefore, the null hypothesis may be retained.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to compare two methods of teaching arithmetic in the second grade, an individualized method and a one-group method, to determine if there were any differences in the achievement made by the two groups. The null hypothesis tested was that there was no statistical difference between the achievement made by pupils in an individualized arithmetic program and in a one-group arithmetic program.

Two second grade classroom groups were selected prior to the experiment. No effort was made to control the variables in socio-economic status, health, home or emotional background of the sample, nor were they matched as to intelligence. However, scores made on Otis Quick Scoring Intelligence Tests showed they were comparable. Distribution of the scores made on these tests are shown in Table II, Appendix A.

The two classes were taught by two different teachers with the control teacher being chosen by the principal as being very comparable to the experimental teacher in teaching ability.

The control class was taught in one group with the teacher giving individual assistance whenever possible to pupils who were having difficulty.

The experimental class was divided into groups on the basis of pre-test scores, demonstrated ability, and interest in mathematics. The groups were flexible and pupils could move from one to another. The entire class worked on the same arithmetical concept, the faster learners given horizontal enrichment, until the teacher was satisfied that even the slow learners had gained an understanding of the process involved.

To evaluate the growth in arithmetical competency, the experimental and control groups were compared on the basis of achievement on the arithmetic section of Metropolitan Achievement Tests, Forms A and B, published by Harcourt, Brace and World.

Form B was administered to both groups early in January as a pre-test, and Form A was given during the last week of March as a post-test. Individual pupil gain is shown on Table III and IV, Appendix A.

Statistical methods used in the analysis were determining the mean gain for each group and the application of a t test to determine any significance in the difference between the mean scores. Statistical findings were reported at the .05 level of confidence. The difference between these two

means was not found to be statistically significant, at this level, and substantiated the null hypothesis.

Conclusions

Although there was no statistically significant difference in the scores made by the two groups, it does appear that the experimental group with a mean of 10.46 tended to achieve higher than did the control group which had a mean of 7.71.

Table III, Appendix A, shows that the greatest gain was made by pupils who made the lowest scores on the pre-test. While it is true those pupils did show a high rate of improvement, the test used was not a good instrument for measuring the growth made by those pupils who scored near the top on the pre-test. Their achievement might have been greater than their scores indicate.

Although the study was designed to measure only the mathematical improvement of the two groups, there were other achievements that could not be quantatively measured which seem to be important. The experimental pupils evidenced continued interest and enthusiasm throughout the study. The slower learning pupils worked without apparent pressure and appeared to be eager for the arithmetic period to begin.

Adjusting to the individual differences in interest, ability and aptitudes of children is a task that calls for

much "plain hard work", an investment in time, materials and skill, but the rewards found in pupil enthusiasm and progress more than compensate for the effort made by the teacher.

No one can supply all the answers to the problem of individualizing instruction in a classroom. Much depends on the attitude of both the teacher and the pupils. There should be a realization from the beginning that every attempt will not succeed, but a single failure should not cause a teacher to give up the entire program. It only indicates the need for re-evaluation and a fresh start (27:381).

Recommendations for Further Studies

On the basis of the information obtained as a result of this study, the following recommendations appear to have merit.

Further research should be conducted similar to this study over a longer period of time, perhaps involving a larger sample.

An effort should be made to more nearly equate the groups, thus eliminating more variables.

A test should be devised which would more adequately measure the total achievement of pupils involved in a modern mathematics program.

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APPENDICES

APPENDIX A

TABLE II

DISTRIBUTION OF SCORES ON OTIS QUICK SCORING TESTS

Experimental Group		Control Group
	140	1
	139	1
1	135	
	134	1
1	133	1
1	132	
1	129	1
	127	1
1	126	4
1	125	
2	124	
	123	1
1	121	
	120	2
1	119	2
1	118	2
2	117	
1	116	2
	115	1
1	114	
1	113	
4	112	
	109	1
2	108	2
1	107	2
1	105	
1	101	
	100	2
1	98	
1	97	
1	93	
	92	1
	84	1
Md_E = 116		Md_C = 118

TABLE III

INDIVIDUAL PUPIL GAIN FROM PRE-TEST TO POST-TEST

EXPERIMENTAL GROUP

Pupil	Pre-test	Post-test	Gain
1	68	64	-4
2	68	72	4
3	65	69	4
4	64	69	5
5	63	67	4
6	63	68	5
7	62	67	5
8	60	68	8
9	58	62	4
10	57	68	11
11	56	62	6
12	56	65	9
13	56	69	13
14	55	69	14
15	55	61	6
16	53	62	9
17	53	65	12
18	53	65	12
19	52	71	19
20	52	65	13
21	52	64	12
22	50	57	7
23	48	61	13
24	46	65	19
25	39	57	18
26	38	59	21
27	38	67	29
28	36	52	16

Mean - 10.46

TABLE IV

INDIVIDUAL PUPIL GAIN FROM PRE-TEST TO POST-TEST

CONTROL GROUP

Pupil	Pre-test	Post-test	Gain
1	67	72	5
2	67	68	1
3	66	69	3
4	63	62	-1
5	62	68	6
6	62	68	6
7	62	67	5
8	59	69	10
9	59	61	2
10	57	66	9
11	57	67	10
12	57	63	6
13	55	64	9
14	55	65	10
15	55	66	11
16	55	70	15
17	54	61	7
18	53	67	14
19	53	61	8
20	51	63	12
21	51	67	16
22	51	59	8
23	48	54	6
24	46	55	9
25	46	58	12
26	46	50	4
27	47	62	15
28	42	40	-2

Mean - 7.71

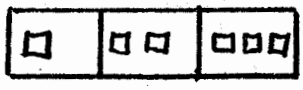
APPENDIX B

JOB CARDS

The following method for introducing the job card in arithmetic was taken from class notes in Individualizing Instruction taught by Jetty Fern Grant, August, 1964.

Take a problem so simple that even the slowest child can solve it. Draw a picture of the problem.

Example: 1 + 2 = 3

Cut paper into strips and fold to show the problem and its solution. 

Then a job card could be introduced which would state; "Do 5 picture problems using the hardest numbers you can. Work at your top level."

Examples of Job Cards

1. Count by 3's. 3, 6, _, _, _, _, _, _.
   2, 5, _, _, _, _, _, _.
   Add 3 to each number
   1, _, 2, _, 3, _, 4, _, 5, _, 6, _.
   Subtract 3 from each number
   4, _, 5, _, 6, _, 7, _, 8, _, 9, _.

2. Study the following addition number facts until you are sure you know them. You may use counters if you are not sure of the answers.

5 + 7 =	7 + 6 =	3 + 7 =
8 + 4 =	9 + 5 =	5 + 4 =
9 + 9 =	6 + 4 =	6 + 8 =
8 + 9 =	7 + 8 =	9 + 7 =

Any number combinations could be used involving subtraction, multiplication, or division, depending on the grade level.

3. Start with zero and count on your paper by 2's to 100.

4. Using your ruler, see how many interesting designs you can make.

5. Make up story problems for these number combinations.

   5 + 6 = 3 + 8 =

   9 - 3 = 2 + 6 + 2 =

6. Show with pictures the meaning of 1/4, 1/2, 3/4.

7. Write the numeral that comes before and after.

   ___, 249, ___ ___, 879, ___ ___, 999, ___

   ___, 509, ___ ___, 440, ___ ___, 634, ___

   ___, 911, ___ ___, 777, ___ ___, 99, ___

8. Find a page in your book which was hard for you. Work 5 of the problems. You may quietly ask a friend for help if you cannot remember how to solve them.

9. Write the numerals that are missing in each row.

   501, 502, ___, ___, 505, 506, 507, ___, ___, ___.

   ___, 898, 899, ___, ___, 902, 903, ___, 905, 906.

   101, ___, 103, ___, ___, 106, 107, ___, ___, ___.

10. Work with a friend with flash cards. Remember to say your answers very quietly so that other boys and girls will not be disturbed.

11. Use the counting disks, if you wish, to find the answers to these problems.

    1/2 of 10 = 1/4 of 8 = 1/3 of 6 =

    1/3 of 9 = 1/2 of 8 = 1/2 of 20 =

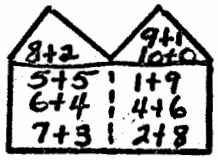
    1/2 of 12 = 1/4 of 16 = 1/2 of 2 =

12. Think! Dick has a stick of candy he wants to break into thirds. How many times will he need to break it? Draw a picture to prove your answer.

13. Take three; add four; subtract 6; add 7; subtract 2. Show your work on your paper. Make up a puzzle of your own.

14. Fold a sheet of notebook size newsprint in half and cut a house from it. On the outside write any numeral under 20 you wish. On the inside write all the number combinations that make that numeral that you can think of. Decorate the front of your house if you wish.

Example:



15. Fill the blanks:

750 means __ hundreds and __ tens
6080 means __ thousands and __ tens
94 means __ tens and __ ones
603 means __ hundreds and __ ones
3400 means __ thousands and __ hundreds
8002 means __ thousands and __ ones

16. Brain teasers--think!
What number is 10 less than 100 more than 7654?
What number is 100 more than 1000 less than 8554?

17. Write the numeral beside each word.

twenty _____ eighteen _____
fifteen _____ seventeen _____
thirteen _____ eleven _____

18. Fold a sheet of paper in half lengthwise, then in half again, and again. Unfold the paper. Using the fold lines to keep the columns straight, write the numerals from 0 to 100.

CHECK SHEET

Solve.

8 +9	17 -9	6 +5	7 +8	11 -4	15 -8
9 +8	17 -8	11 -7	11 -4	15 -7	5 +8
7 +7	16 -6	10 -8	13 -6	14 -8	14 -6
4 +9	14 -5	5 +9	14 -9	9 +5	5 +7
9 +4	13 -9	11 -6	10 -6	16 -9	15 -9

FIVE MINUTE CHECK SHEET

Find the Sums.

8 +9	17 +2	6 +5	7 +8	9 +8	5 +8
7 +1	10 +8	4 +9	5 +9	9 +5	6 +7
9 +5	5 +6	3 +7	9 +7	10 +10	7 +9
6 +3	7 +4	9 +6	6 +9	5 +7	4 +3
1 +5	2 +3	9 +1	8 +7	6 +5	7 +4
5 +3	6 +4	4 +6	9 +5	8 +4	7 +6

FIVE MINUTE CHECK SHEET

Find the Differences.

17 − 9	11 − 4	11 − 5	15 − 8	17 − 9	13 − 8
14 − 7	10 − 8	13 − 9	14 − 9	14 − 5	13 − 7
14 − 8	13 − 5	10 − 7	16 − 7	10 − 10	16 − 9
9 − 3	11 − 7	17 − 7	15 − 6	12 − 7	12 − 8
6 − 5	5 − 3	15 − 9	15 − 7	11 − 6	10 − 2
6 − 3	8 − 4	18 − 8	12 − 6	9 − 7	10 − 6

WORKSHEET