AN EXPERIMENTAL COMPARISON OF PUPIL PROGRESS IN SEVENTH-GRADE ARITHMETIC ON THE BASIS OF THE FORMAL AND THE ACTIVITY PROGRAMS OF TEACHING PROCEDURE

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CHAPTER I

AN INTRODUCTION TO THE STUDY

Statement and Definition of the Problem

The classroom projects which form the basis of this thesis were carried on in the seventh-grade arithmetic classes of the writer, who is a member of the faculty of the Denton Junior High School. Since she desired to make a study based on the teaching of arithmetic by the conventional and the activity methods, the writer, in September, 1940, organized two of her seventh-grade classes in such a way as to accomplish a situation that would facilitate this purpose. Thirty-five pupils were enrolled in each of the two classes, and were arranged in the two groups as equally as possible according to sex and to intelligence quotients. With this organization, the writer believed that neither class would have an advantage over the other.

The next step was to begin the teaching of seventh-grade arithmetic according to two distinct techniques, in an effort to discover, during a semester of work, whether any significant differences would be manifested in pupil progress when arithmetic was taught by the formal or conventional method and when the activity technique was employed in the classroom procedures.

Description of the Situation of the Study

Little need be said regarding the set-up for the conventional or formal arithmetic class, as it was completely traditional in nature and organization. Textbook assignments were utilized from day to day, and much outside written work based on textbook problems was required. Class periods were utilized for the discussion of the problems and for assistance from the teacher for those pupils who had experienced difficulty with the assignment. Drill on fundamental processes and on skills was a frequent practice, occurring usually at the pupils' desks rather than at the blackboard; and flash cards were employed occasionally.

An entirely different organization was used in the class that functioned in terms of an activity program. Although minor units on transportation and hobbies were employed during the semester, the principal project was a "store enterprise" that continued throughout the semester. The cafeteria in the school is under the management of the Home Economics Department of the Texas State College for Women, which purchases all materials used in the cafeteria. The arithmetic class obtained permission to have charge of the selling of such items as cold drinks, candies, and all types of school supplies carried in stock by the cafeteria.

This authority did not include the selling of foods prepared in the cafeteria. Two pupils from the arithmetic class were on duty at all times in the store, each pair of workers serving for the duration of a class period and being relieved at its end by others. All sales were entered in the books, and articles sold were carefully classified when entered. Each group of storekeepers, at the end of their period, were able to tell their successors the amount of the total sales they had made. At the close of each day, the total for the day was calculated. It was found that the average daily sales throughout the semester amounted to approximately four dollars. During the semester, each pupil had an opportunity to work in the store. Some of the children worked much more than others because of a more flexible schedule or because of greater proficiency in mathematics. It had been understood before the beginning of the project that those pupils who did not maintain a high standard of work in arithmetic would have to give up their work in the store until they had become more proficient in mathematics. This rule was believed to provide a strong incentive for better work in arithmetic, for all of the pupils thoroughly enjoyed serving as storekeepers and worked hard to prevent the withdrawal of this privilege.

In the regular class period, the pupils and the teacher discussed the progress of the unit and presented any problems that had arisen in connection with its operation. Before the store was opened, such factors as business organization, plans for going into business, and inventory were thoroughly discussed. Drill and practice in problem solving were employed in the class period when a need was felt for them. Charge accounts were discussed, and it was decided to extend credit to a pupil only upon recommendation from the principal of the school. This arrangement worked very satisfactorily.

Definition of Terms

Perhaps a few terms that appear frequently throughout this study need a certain amount of clarification at this point.

Pupil progress. -- Pupil progress, as employed in this particular experiment, means the number of points gained or lost by the pupils at the close of the semester when they were given another form of the same standard arithmetic achievement tests that had been submitted to them at the beginning of the semester.

First test and second test. -- These terms, used rather extensively in the tabulations and in the text, mean, respectively, the beginning-of-the-semester test and the close-of-the-semester test. The tests referred to were standard arithmetic achievement tests.

Store class. -- This term sometimes appears in this thesis, and always refers to the class which was taught by the activity method, and is at other times referred to as the "activity class" or the "activity group." The descriptive words, "traditional," "formal," and "conventional" are used interchangeably to indicate the other class included in the experiment, in which no activity units were employed.

Sources of Data

Data for this study were obtained by the use of Speer and Smith's Arithmetic Reasoning Tests and Arithmetic Fundamentals Tests in the National Achievement Tests series. The tests used in this experiment are published in two divisions, called Form A and Form B, both of which contain similar material dealing with identical processes. Form A of both tests was submitted to both classes at the beginning of the semester, and Form B of both tests was submitted at the close of the term's work. On both occasions the scores were carefully tabulated and recorded by the writer.

Organization and Treatment of Data

Before presenting the data derived from the submission of the tests mentioned above, the writer, in Chapter II, has prepared a survey of literature on the conventional and activity methods of teaching arithmetic, and has summarized a number of previous studies that, in one way or another, are related to the present one.

In Chapters III and IV appear tabulations and analyses of the data from the tests for the purpose of showing pupil progress, respectively, under the formal or conventional procedure, and under the activity procedure.

The fifth chapter is an analysis of pupil progress under the two distinct techniques of teaching, intending to show comparisons.

The last chapter is a brief summary of the study that also suggests a number of conclusions and recommendations that, the writer believes, are warranted by the outcomes of the experiment.

CHAPTER II

TEACHING ARITHMETIC BY THE FORMAL AND THE ACTIVITY PLANS: A SURVEY OF LITERATURE

Units and Activities in General

Methods of teaching all subject matter have undergone striking and far-reaching changes in recent years. The acquisition of an education is no longer a procedure of passing knowledge from the mouth of the teacher into the head of the pupil, but it has become an active search on the part of the learner for truths and concepts that are workable and meaningful in a never-ending procession of vital problems and real-life experiences. The teacher is no longer the source of knowledge, but has assumed a more important role -- that of a guide to assist the child in discovering for himself the knowledges that he requires in his school and community environments. Hence the learner has become a seeker and an experimenter, and is rapidly outgrowing his former status as a passive absorber. The schoolroom has become a place of activity, and has lost the dullness of unexciting routine. All of these changes and others came into being when educators evolved the concept of the unit or activity as a technique of teaching and of learning.

The unit, with all its multiple opportunities for learning, put into the pupils' hands the keys to the storehouse of knowledge, and permitted them to explore its treasures without hindrance. The unit tended to make the processes of education more palatable, and certainly more worthwhile. Unfortunately, every unit does not rise to a high plane of value to the individual pupil, for some units are inevitably poorly planned, improperly timed, and lacking in challenging material. Charters' standards for a successful unit -- that it must be comprehensible, useful, and interesting[1] -- have become generally accepted in theory, but are not always attained in practice.

The activity as a classroom project has been defined by the supervisor of elementary education in the Berkeley, California, schools as follows:

> An activity is an enterprise organized by a pupil or a group of pupils, under the leadership of the teacher, to further classroom study. Such an activity requires purposing, planning, evaluating, deciding, selecting, eliminating, organizing, constructing, or creating. It implies seeing, hearing, expressing, doing, and appreciating, and affords opportunity for the child to acquire information, weigh values, make decisions, develop attitudes, and make behavior responses in connection with real situations.[2]

If all of these requirements and implications of an activity are to be realized, the unit or project must contain a wide

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[1] W. W. Charters, Curriculum Construction, pp. 97-100.

[2] Lewis W. Smith, "A Quantitative Study of an Activity Program," Elementary School Journal, XXXIII (May, 1933), 670.

utilization of diverse subject matter. In fact, authorities are agreed that an activity should call into use as many as possible of the subjects in the school's curriculum.[3]

Baxter, a teacher in the Lincoln School, Columbia University, declares that "by a unit of work we mean the various experiences and activities of a grade which center around some one interest."[4] She continues by asserting that, in the main, more effective teaching and learning can be attained if a class is conducted on the basis of units of work rather than subjects of study. She admits, however, that teaching by units of work rather than by subjects of study has been severely criticized by some educators because there is a tendency to neglect or to minimize the skills. Probably this tendency is characteristic of the unit method of teaching, Baxter concedes, and confesses that in her own use of units of work, "there are so many more interesting things in process that there is a temptation to do the other things and let the skills take care of themselves." Some children acquire the necessary skills in arithmetic, in oral and in written English, in placing pictures on a page, and other skills that may enter incidentally into the unit, but most children must first be taught a process or a skill and then must be provided with an opportunity to use it. Some children,

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[3] _Ibid._, p. 671.

[4] Tompsie Baxter, "Some Techniques and Principles Used in Selecting and Teaching a Unit of Work," _Teachers College Record_, XXXI (November, 1929), 148.

of course, need more practice than others, but Baxter[5] believes that before a pupil enters upon an activity, he should have mastered the skills that may be required of him in carrying it to completion. Hence, although Baxter looks with favor upon the unit, she does not encourage the purely incidental acquisition of skills that too often characterize the employment of the unit in classroom work.

Aims of Arithmetic

What has been noted in the preceding paragraphs in relation to units and activities in general is readily applicable to the teaching of arithmetic by the unit plan. Here, as in the teaching of all other subjects, no teaching has been done if the child has not been reached.[6] Any subject, to "reach" the child, must be made to hold some meaning for him in life situations. Usefulness in life is the real justification of arithmetic in the schools, conclude Wilson, Stone, and Dalrymple, after quoting a number of authorities. The simple idea that arithmetic should be helpful and meaningful to the children at the time they are studying it has come generally to be accepted among most modern educators, but it had many setbacks before it gained any influential champions. Arithmetic, for a long while, was considered not only for its potential value to the future adult, but also for its peculiar

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[5] *Ibid.*, pp. 156-157.

[6] Guy M. Wilson, Mildred B. Stone, and Charles O. Dalrymple, *Teaching the New Arithmetic*, p. 65.

ability to develop accurate thinking and to sharpen the memory -- in short, for its purported contribution to the long-popular theory of formal discipline.[7] Modern educators, however, would be tempted to throw arithmetic out of the schools if it had only these functions to warrant its position in the curriculum. The new attitude toward the subject is that

> The study of arithmetic must lead to a fuller understanding of many of life's problems from a quantitative point of view. We study current problems from economic, social, artistic, and ethical aspects. Similarly we may interpret these questions from a statistical or a quantitative viewpoint. . . . Arithmetical interpretations add new views to experience and thus enrich our understanding of certain social questions.[8]

Arithmetic must enable the learner to be socially more efficient, and it should be so taught as to enable him to begin his increased efficiency in the schoolroom. Once arithmetic was taught in the school and was used, if at all, years later; and much of what was learned was never used in life by the average adult. The present tendency is to avert this theory that one should learn today what one may need tomorrow, and to bring about in the classroom situations as nearly analogous to life circumstances as is possible, and make available to the pupils a functional arithmetic adapted to the present needs of the individual learner. Naturally, the underlying motives in this method are to increase accuracy,

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[7] *Ibid.*, p. 14.

[8] Paul Klapper, *The Teaching of Arithmetic*, pp. 5-6.

to encourage the planning of procedure, and to reduce the checking of results to habit[9] -- all of which will contribute to the pupils' social efficiency and success.

Incidental Arithmetic

As is often true of a reaction of any kind, the first departure from the conventional method of teaching arithmetic was one that swung to the opposite extreme. It was called the incidental method, and gave no place to drill, textbook problems, and other practices that had been considered fundamental to the learning of arithmetic. The incidentalists were convinced that the child will get all the arithmetic he needs, and will learn it more effectively, if it is not systematically taught. All arithmetic should grow out of the natural activities and interests of the children. This theory was a natural reaction against the pure, meaningless drill idea, and is waning rapidly in popularity because it is by no means adequate or effective.[10] It works more successfully in the books that the theorists write than it does in the classes that they teach.

The incidental method is not adequate for the development of skills in arithmetic on the part of the children, because of the very small amount of number work that is actually found in each grade when arithmetic enters into the curriculum

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[9] *Ibid.*, p. 3.

[10] C. W. Webb, "Significant Trends in the Teaching of Arithmetic," *The Texas Outlook*, XXIII (October, 1939), 33.

only incidentally. It should be pointed out here that the true activity or unit is not incidental teaching, for definite objectives are always in mind in advance, and the work is carefully planned so as to make their attainment possible. As distinguished from incidental teaching, the activity substantiates the fact that "children profit greatly from an organized arithmetic program which stresses number concepts, relationships, and meaning."[11]

> The extreme incidental program of number teaching is one which has not been predetermined by teacher or pupil but which aims to utilize the natural interests of pupils in numbers as they occur in their classroom activities. Number learning in such a program is a by-product of the activities in which children engage. Briefly, it is a program in which things happen without much design. . . .
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> An organized program of teaching may be defined as one for which a course of study has been determined and outlined in advance and is followed more or less closely in the classroom. The fact that the program has been planned in advance does not preclude the possibility of utilizing opportunities for motivation nor the use of "true-to-life" situations in the teaching of numbers. The distinct difference between the two programs is in the degree to which they are planned in advance. For example, the teacher on the organized program may make the acquisition of certain number concepts, facts, skills and abilities one direct aim of teaching but not to the exclusion of other desirable aims. On the other hand, the chief concern of the teacher on the incidental program is to satisfy specific inclinations and interests of children by providing opportunities for participation in classroom activities largely initiated by pupils, irrespective of the control gained over any specific knowledge or skills.[12]

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[11] C. L. Thiele, "An Incidental or an Organized Program of Number Teaching?," The Mathematics Teacher, XXI (February, 1938), 64-65.

[12] Ibid., p. 63.

If mathematics teachers were expert at guiding the interests and attentions of children into worthwhile activities, and if they possessed adequate knowledge of the foundations of arithmetic, there likely would be no serious problem of incidental learning, for all experiences would center around challenging activities employing directed learning and planned objectives.[13]

Old and New Techniques in Arithmetic Teaching

In the period of transition from the old to the new in methods of teaching arithmetic, the first point of view in connection with the enrichment of the curriculum was that only the brighter children were prepared for and should be given extra or more interesting work aside from the required procedures. The slower individuals, who were experiencing some difficulty in mastering the essential processes, should continue to spend all their time in drill work. The fact is now coming to be recognized that any child with an intelligence quotient as high as eighty can master all of the fundamental processes that have been proved, by actual investigation, to cover more than ninety per cent of all the mathematical information that the average adult will ever require in carrying on his affairs or in working his way out of perplexing situations. Although it is true that some pupils require more drill than others, there is no justification

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[13] *Ibid.*, p. 67.

for limiting the arithmetical activities of the slower children to monotonous drill, whereas those who are more competent are permitted to vary their drill with interesting and captivating activities. Instead,

> There should be for all children opportunities for meaningful activity. This, properly organized, means enrichment of the content of the course, and this for the most part will take the form of worthwhile problem units. In some cases, it will take the form of appreciation units.[14]

These new approaches to the learning of arithmetic imply a drastic departure from the conventional methods, characterized by the required solution of an endless series of problems that, in the main, had been worked out without regard for the lives and interests of the children, and often without having taken into consideration the vital interests of human beings at any age.[15] The thing that was important was having a problem to solve; whether it could conceivably be related to the lives of the children was of little or no significance.

> In the older schools and in poorly staffed schools today there are much meaningless drill, little or no purposeful problem work, and nothing approaching acceptable informational units in arithmetic. In the better schools today, drill is sufficiently deferred and never undertaken without an adequate basis in meaning and motivation; the problem work is based not upon disconnected, unappealing puzzle situations but upon real problem needs of the child in home and

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[14]Wilson, Stone, and Dalrymple, pp. 42-43.

[15]Edward Lee Thorndike, <u>The New Methods in Arithmetic</u>, p. 25.

> community; and the informational units are based upon individual or group choice and thus become a personal contribution to larger group insight and interest.[16]

In the traditional class in arithmetic, the textbook is utilized religiously, and the pupils are expected to solve all or nearly all of the examples and problems, regardless of need, practicability, or understanding. Unfortunately, perhaps, this situation is by no means unknown at the present time, although it possibly would be more appropriate to speak of traditional arithmetic in the past tense, since it is slowly becoming obsolete. The traditional course went far beyond the simple tool materials in the four fundamental processes and in simple fractions, percentage, and interest. It included, on a drill basis, compound and complex fractions, all possible procedures in decimals, all possible processes in denominate numbers, ratio and proportion, alligation, position, square root, cube root, progressions, and mensuration.[17] Needless to say, many of these processes had no value for the child at the time he was learning them, nor would they ever be of value to him throughout his life. When examined from the standpoint of utility, they were utterly impracticable. Consequently, they were usually sheer monotony for the child and a senseless waste of his time and energy. Because the arithmetic curriculum was so overloaded with this type of material, many pupils developed a robust

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[16] Wilson, Stone, and Dalrymple, p. 57. [17] Ibid., p. 34.

dislike for the subject itself. This picture is now, however, beginning to change.

> The total effect of the simplified, functional program is confidence, success, and a liking for arithmetic. The useless grind has been replaced by a sizable load, properly understood and adequately motivated. The essentials will be perfectly mastered. The child will know where to go for help on the little-used processes, without being depressed by impossible requirements for mastery. The child will enter high school better prepared to succeed because of favorable attitudes and because he comes with the most needed tools perfectly mastered.[18]

When arithmetic ceases to be a tool that persons know how to use in living, it is worthless. Arithmetic is more in need of integration than any other subject, for it has been too abstractly presented. As it has been too often taught, it has not caused pupils to become adequately acquainted with the real problems that arise in life or with those that are vital to the individual's welfare. The subject in the past has been taught more or less aimlessly, without a definite purpose other than the acquisition of knowledge and skill; and as a result, the facts learned have not long remained in the minds of the pupils. In their day, the old methods were good, and some are still good, but many need to be replaced with new ones that will "give facts that will sink in, knowledge that will inspire, problems that will stimulate interest and confidence and courage for the real situations of life." No one method is sufficient, for many methods are needed; and "the one that stimulates the

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[18] Ibid., pp. 36-37.

intellectual life of the pupils most is the one that affords the greatest opportunity for the pupils to recognize and solve their own problems."[19]

Meaning is now held to be essential to the adequate teaching of arithmetic. There is certainly a place for practice and for various approaches that lead to insights and meanings, but unmeaningful drill is of questionable value. Teachers make as much use of incidental number experiences as possible, but there is a stronger tendency to use social situations to motivate number ideas and skills, and to employ numbers in the solution of everyday problems. "Thus, there is an attempt to use incidental and planned experiences as a means of making numbers socially significant and mathematically meaningful."[20] There is a definite trend toward the selection of the content of arithmetic and mathematics courses on the basis of social usefulness and the possibility of effective use. In keeping with this plan, many arithmetic concepts and processes are being deferred until a need for them is felt and the child is sufficiently matured to assure that the particular concepts and processes will be meaningful to him.

In the past, the practical value of arithmetic was emphasized to an unreasonable degree; children were promoted

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[19]Verti Buchanan, "Arithmetic Unit Work," The Texas Outlook, XX (May, 1936), 29.

[20]Webb, p. 33.

or retained according to their mastery of this one subject, which was considered to be the most important one in the curriculum. Now, however, the fact is widely recognized that to go beyond the bounds of social usefulness is likely to involve a waste of time and energy for both the teacher and the pupil, and needlessly to discourage the pupils, especially those of average or below-average intelligence.[21]

> In general, everywhere, the newer methods try to teach not merely arithmetic, but arithmetic as a help for life. They seek to find just where and how each feature of arithmetic should serve boys and girls while they are in school and after they leave school, and to teach it in such a way that it will serve them. They ascertain the facts of reality with which each arithmetical fact or principle needs to be connected and help the pupil to make the connection.
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> The older custom of teaching the facts about feet, yards, pints, quarts, gallons, etc., off by themselves in a chapter on "Denominate Numbers," with the multiplication and division tables in other chapters by themselves, wasted a chance to make arithmetic serve life and made both topics harder to learn.[22]

> The progressive teacher who is alert to the situation involved will find many activities by which he or she can socialize arithmetic and at the same time be efficient in his work. Socializing arithmetic does not mean the omission of any of the fundamental processes; it means a change in the fundamental concept of learning. The pupil does not study the various processes for the sake of knowing the process, but he has an immediate problem in hand which he must solve and the knowledge of the process is necessary for the solution of his problem. Therefore, the results are the same, but the method was not nearly so painful.[23]

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[21]Klapper, p. 6.

[22]Thorndike, pp. 6-7.

[23]Chester Strickland, "Soup in the Arithmetic," <u>The Texas Outlook</u>, XXI (May, 1937), 53.

The newer methods of teaching and learning arithmetic

> . . . stimulate the pupil to reason out what is to be done so far as he is able. They do not favor mechanical as against rational learning. But they take pains to see that somehow he does actually acquire the new habits, form the new bonds, and have enough practice with them to keep them alive and active.[24]

The old technique of continuous and never-ending drill often caused the child to become sick of the monotony of figures, many of which were almost if not quite meaningless to him. By the time the children had mastered the necessary mechanics of figures, they were weary of problems and exercises from the book, but were given little opportunity to become acquainted with practical problems which might contribute something to their financial success in adult life. One teacher in a modern school, realizing the value of the activity as a means of teaching and learning arithmetic, but not willing to abandon completely a certain amount of drill in the fundamental processes, inspired her class to carry out a practical project, which took the form of the construction of a miniature city, with buildings, streets, and parks worked out carefully to scale. In addition, banking and merchandising activities were engaged in by the class in accordance with the common practices found among adults in a real city.[25] Needless to say, the fundamental

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[24]Thorndike, p. 68.

[25]Mrs. J. B. Osborne, "Making Arithmetic Interesting," _The Texas Outlook_, XX (September, 1936), 62.

procedures were adequately learned without the monotony of meaningless drill; and the additional value of enabling the children to carry on practical real-life activities is certainly commendable.

Even today the drill theory of the teaching of arithmetic is by no means abandoned. Its proponents continue to advocate the principle that the child should master all the arithmetical processes whether he understands them or not, because he will need them in later life. The disadvantage of this concept is that it appears completely to neglect or ignore that which is now recognized as most vital -- the social value of arithmetic.[26] Every one recognizes, however, that some drill is necessary. This means that the old method was not entirely bad, but that its excessive use is to be frowned upon. Some authorities advise teachers never to proceed with drill until they are sure that the meaning of the drill is perfectly clear to every pupil, and that an impelling interest has been established that will lend meaning to the drill.[27]

A junior-high-school group, on a field trip, utilized the occasion for making mathematical calculations as to distances, heights, and angles. The idea behind the observations was that mathematics should be related to community

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[26]Webb, p. 33.

[27]Wilson, Stone, and Dalrymple, p. 64.

and social activities as a means of preparing children for a better understanding of the social and physical sciences. The group took dozens of photographs showing various types of perspective that would bring in mathematical implications, burned property that would naturally lead to a study of insurance, motor accidents that clearly led to insurance and safety investigations, and many other similar types of pictures. In this way, and in many other ways, the human approach to mathematics is being emphasized, but the development of skills and accuracy in the mastery of essential mathematical material is not being overlooked or minimized. This is still a fundamental part of the mathematics program, as it has been for years, but with a different approach and with significantly different implications and purposes. Modern methods have no intention of "soft-pedalling" mathematics, but they do admittedly contain an effort "to offer stimulation to put more brain cells into operation by calling upon the application and comprehension of the concepts of the subject matter." Children are becoming justly critical of all material handed to them in the conventional manner, and they have a perfect right to demand that subject matter be approached in a more comprehensive and functional way. Teachers should consciously endeavor to develop an experimental attitude that will assist them in finding ways to make mathematics in the junior high school alive, functional, and thorough. "Mathematics is not on the way out --

mathematics is really on the way in if it can be made functional, livable, and comprehensible."[28]

> Teachers in the past have too often been content to assign any problem that was a problem. They have assumed that the discipline the mind received from trying to discover the solution of any problem which required thinking was so valuable that it did not much matter whether the problem was real or artificial, well or ill stated, common or rare. For this they have had some justification, or at least some excuse; for it is true that solving arithmetical problems is one of the best single tests of intellect that psychologists have yet found; and that a problem may be a good exercise for the intellect even though its data are foreign to, or even contrary to, experience.
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> However, it seems certain that if we take enough pains and have enough ingenuity, we can find an abundance of problems which will exercise the intellectual powers as well and at the same time prepare the pupils more fully and directly to apply arithmetic to the problems they will really encounter in life. So the newer methods . . . set a higher standard for problems. A problem should, preferably, (1) deal with a situation which is likely to occur often in reality; (2) in the way in which it should be dealt with; (3) should make the situation neither much harder nor much easier to understand than it would be when really present to the pupil's senses; and (4) should be supported by somewhat the same degree of interest and motive as attach to the problems which the pupil will meet in the actual conduct of his affairs.[29]

Arithmetic, when taught in the modern way, makes a strong appeal to two important child interests -- the interest in mental activity and the interest in achievement. Many children like arithmetic for the same reason that they like intellectual games such as puzzles, riddles, checkers, and chess. Most children like to have definite tasks so they

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[28]David W. Russell, "Introducing Mathematical Concepts in the Junior High School," School Science and Mathematics, XXXVIII (January, 1938), 8, 18-19.

[29]Thorndike, p. 125.

will know what they have to do and when it has been accomplished, and feel that they have merited the rewards of action, achievement, and mastery. If arithmetic is taught in a manner that is at all efficient, it is one of the best of intellectual games that the school can provide, and its tasks are so definite that the pupil can readily know what must be done, his rate of progress, and his degree of achievement. "The newer methods increase the strength of these two appeals, making arithmetic a more attractive game for young intellects and giving the interests in achievement and mastery greater stimulus and fuller play."[30]

> Other things being equal, work will be more interesting to children in proportion as there is physical action, variety, sociability, a chance to win, a practical gain, a connection with something or somebody that one cares for, and, most of all, perhaps, a significance for some aim or purpose that is a ruling factor in one's life at the time.[31]

Units and Activities in Arithmetic

As newer methods of teaching and learning arithmetic are coming into general acceptance, the old textbook-and-drill techniques are being superseded by units and activities that are challenging to the interests and abilities of the pupils. In the lower grades, the purpose of the problem unit is the extension of meaning and experience on the part of the young learner to whom arithmetical concepts are comparatively new and mysterious. In the higher grades, after the fundamentals

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[30] *Ibid.*, p. 14.

[31] *Ibid.*, p. 25.

have been mastered, the purpose of such units becomes the development of judgment and of discrimination.[32]

> In the field of problem solving, the problems set by the textbook author or by the teacher are not lifelike situations. Problem solving in real life necessitates the collection of information and the setting up of the problem by the one who is to solve it.[33]

Despite the uses to which arithmetic is put in many modern units and activities, it is not a leading subject in connection with the origin of such activities. Of 461 classroom activities studied in the Berkeley, California, elementary schools, only six originated in the subject of arithmetic, as contrasted with 210 in the social studies, fifty-three in reading, forty-seven in nature study, thirty in languages, etc. However, arithmetic was employed as a vital vehicle in the development of 105 of the activities which originated in other subject-matter fields.[34] Hence arithmetic is an important tool in the development of units of work, although the part it plays in the initiation of activities is decidedly inferior to that of many other subjects found in the curricula of modern schools.

It is generally admitted that few teachers make full use of all the actual-life situations that arise in their classrooms, but, on the other hand, it is perhaps a good thing that not all the work is motivated entirely through

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[32] Wilson, Stone, and Dalrymple, p. 317.

[33] Ibid., p. 58.

[34] Smith, pp. 671-672.

this type of activity. "Therefore, the teacher uses the situation that is real outside of school, imitating it as closely as possible in the phases of arithmetic involved. Such life activities as the grocery store, bakery, cafeteria provide interest and create a need for many facts and process steps."[35]

> We have learned to think of teaching as providing the most instructive experiences and the most instructive activities, so organized and arranged as to produce maximum knowledge of arithmetic as a science and skill in arithmetic as an art. The teacher may be thought of as a general who protects his army against such and such dangers, extricates them from this or that trap, and provides them with the best weapons and ammunition. Or she may be likened to a guide who prevents his party from taking wrong paths, helps them out of pitfalls and crevasses, and provides them with proper ropes, staffs, and axes. So the teacher's work includes measures to avoid misunderstandings and false steps, the diagnosis and cure of difficulties, and the selection or invention of just the best means for learning each topic.[36]

Harap and Mapes have reported in detail certain activities that were selected deliberately because they were rich in applications of fundamental processes in multiplication and division of fractions and in denominate numbers -- studies commonly included in the second half of the fifth grade. Their summary of the activities is enlightening and interesting from the point of view of one who is interested in the modern techniques of teaching arithmetic through activities:

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[35]Wilson, Stone, and Dalrymple, p. 63.

[36]Thorndike, p. 147.

> . . . the activities were genuinely real on the child's level of maturity. They were based on meaningful situations in the child's experience in school and out of school. The children participated in selecting and planning the units of work. The actual life-situations were, as far as possible, reproduced in the classroom. The materials utilized were those which occur in life. The activities included weighing and measuring materials, cooking meals, sewing garments, serving meals, purchasing goods, eating meals, reading recipes, entertaining children and adults, decorating classrooms, making baskets, assembling and arranging furniture, and other equipment, cutting paper, consulting parents, obtaining estimates, comparing prices, organizing into committees, calculating costs, calculating quantities of materials, preparing food baskets, estimating the needs of families, handling foods, and so on. There was maximum participation on the part of the pupils. The pupils communicated and associated freely as the need arose. They had abundant opportunity to choose, to judge, and to evaluate. Every unit came to a logical and natural close.[37]

Among the larger units considered and completed in this teaching situation reported by Harap and Mapes were the following: a candy sale, understanding the advantages of the inclined plane, a mothers' party, baskets for two needy families, preparation of a luncheon for the first grade, making a quilt for a children's hospital, and serving a teachers' luncheon. The duration of each unit was from eight to twelve class periods. All units except one called for some purchasing activities by the pupils, and all except two involved the selection and the preparation of food. The unit on quilt-making necessitated some participation in designing

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[37]Henry Harap and Charlotte E. Mapes, "The Learning of Fundamentals in an Arithmetic Activity Program," _Elementary School Journal_, XXXIV (March, 1934), 515-516.

and sewing. Four of the units involved some selling transactions.[38]

In the experimental class, which consisted entirely of activities, Harap and Mapes made a recording of the intelligence quotients of the pupils and then divided the class into halves for the purpose of comparison. Each pupil in the upper half of the class had an average intelligence of 121.4, and in the lower half, of 104.4. The upper section mastered 87.6 per cent of the arithmetical processes involved in the activities, whereas the lower group mastered 79.4 per cent. Hence the intelligence quotients of the pupils constituted only a minor factor in accounting for the outcome of the experiment.[39] The authors, after having made a careful analysis of all factors involved, concluded that, if good teaching is in evidence,

> . . . an arithmetic program based on real situations in school and social life incorporating the basic arithmetical steps of a grade may be undertaken with considerable assurance that these steps will be mastered.[40]

When the children who participated in the experiment summarized in the preceding paragraphs had reached the sixth grade, Harap and Mapes conducted another experimental course in arithmetic that involved only those children who had contributed to the previous study. Here again the children's intelligence quotients were found to be insignificant factors

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[38] *Ibid.*, pp. 516-517. [39] *Ibid.*, p. 521. [40] *Ibid.*, p. 525.

in the outcomes connected with the mastery of decimals. The experiences made available to this class, as had been the case in the fifth grade, were real and varied, including keeping accounts, making talks to classes, comparing evaporated with whole milk, making graphs, selecting recipes, making cocoa, sampling tooth powders, calculating relative costs, selling glaced apples, figuring profits, etc. A maximum amount of pupil initiation and participation was encouraged. Although most of the units were anticipated by the teacher, they were taken up willingly by the pupils because of their intimate relation to situations that were meaningful and natural to them. At every step of the way, there was abundant opportunity for self-expression and critical judgment. Much of the time usually consumed by drill and problem-solving was devoted to construction, manipulation, and other activities. Thirteen major units were included in the year's work: school banking, keeping spelling records, community fund, using milk, making tooth powder, school fund, making furniture polish, making ink, making hand lotion, making paste, making glaced apples, making presents for mother, and making a garden. For purposes of comparison, the first and final tests on the twenty-seven fundamentals in decimals were given also to a conventional class taught by an experienced teacher with a commendable record. The experimental group mastered ninety-seven per cent of the total processes, whereas the control group mastered only sixty-seven per cent. Hence the experimental group unquestionably had achieved a better mastery than the control group. The processes occurring only a few times were learned as well as those which occurred many times in the course of the year's activities.[41]

In a small Texas school the sixth and seventh grade arithmetic classes undertook the preparation and selling of simple lunches to pupils, since the school had neither a cafeteria nor a home economics department. The pupils had to figure the quantities of foodstuffs required, to handle the grocery orders, to know percentage in making change and in computing amounts of food, and to be familiar with the fundamentals of bookkeeping. They checked all accounts each week and sent out statements to customers. The unexpected happened: there were no failures in arithmetic in either class. The explanation of this situation seemed to be that the children were eager to learn arithmetic in order to solve the immediate problems in which they all were interested.[42]

Two recent projects in junior-high-school arithmetic had to do with the problems connected with the building of a home. The respective classes participated in the selection of suitable building sites, engaged in the business transaction

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[41]Henry Harap and Charlotte E. Mapes, "The Learning of Decimals in an Arithmetic Activity Program," Journal of Educational Research, XXIX (May, 1936), 686-693.

[42]Strickland, p. 53.

of purchasing the selected lots, consulted architects, and conferred with the mechanical drawing classes, members of which drew and blueprinted the plans for the house. The next step was to consult lumber dealers to get estimates of the quantity and cost of materials. Contracts were let, and the classes co-operated in the actual construction of the houses according to the plans. Then came the problems of decorating, insuring, and landscaping; and, finally, the houses were sold. This type of unit provides training in all phases of linear, square, and cubic measurements; enlarges the pupils' vocabularies with practical meanings; and gives the children valuable experiences with money, with the figuring of interest, and with various types of practical business transactions, besides offering opportunity for the further development of mechanical skills.[43]

Hizer and Harap conducted an experimental activity course in sixth-grade arithmetic, which involved the following major units: (1) planning total and individual costs for menu, entertainment, and decorations for annual class party; (2) a study of banking procedures of the school bank and of commercial banks, including depositing, computation of interest, withdrawing, budgeting, balancing books, etc.; and (3) a candy sale, involving quantitative estimates of materials, exact measuring, cost of materials, and calculating

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[43] Lillian Barclay, "Home Ownership as an Arithmetic Unit," The Texas Outlook, XX (September, 1936), 40. See also Verti Buchanan, "Arithmetic Unit Work," The Texas Outlook, XX (May, 1936), 29.

individual and total profits. The authors concluded, as a result of these activities in arithmetical processes, that:

> To one who is concerned about the mastery of fundamental steps in arithmetic, it seems safe to recommend a series of child-centered activities provided that they are accompanied by individual practice exercises for pupils if, and when, they are needed, plus periodical tests of mastery of the essential steps.[44]

Since initiative, resourcefulness, and self-activity are highly significant in the activity program, it is important to know whether a group of pupils or the class as a whole is responsible for the origin of an activity, or whether it is initiated by the teacher. In a Berkeley, California, study of 461 activities, the largest number, 160, were initiated by the teacher. In eighty-eight cases, groups of pupils in a class started the activity; in seventy-five instances, the teacher and the class together were responsible; individual pupils inaugurated sixty-five of the activities; the class as a whole was responsible in forty-seven instances; a group and the teacher, in sixteen cases; and miscellaneous persons or groups, in eight cases. In two instances, the question as to the origin of the activity was not answered. A higher degree of uniformity was noted in the execution of the activities, the class being responsible in 406 cases, class groups in forty-nine,

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[44]Irene S. Hizer and Henry Harap, "The Learning of Fundamentals in an Arithmetic Activity Course," Educational Method, XI (June, 1932), 539.

and individual pupils in six.[45] It is significant that the teacher had no prominent part in the execution of the activities, although she was responsible to some extent in their initiation.

That the unit or activity is a highly significant development in the teaching of arithmetic is readily conceded by all educators. Once more it should be pointed out, however, that the activity that incorporates the largest number of subject-matter fields is the best and most meaningful activity. A typical opinion regarding this fact is the following:

> There has been a tendency to think of arithmetic as something related to nothing, but since there is a quantitative side to the important problems of human activity, arithmetic is related to the other subjects. Nothing will do more to bring out this important relationship than the integration of arithmetic with the other subjects of the curriculum into a large unit of teaching.[46]

As a type of summary of the modern methods of teaching arithmetic, the following characteristics of the problem unit are valuable:

1. The work in the class should grow and develop naturally and, preferably, should originate in the experiences of the children themselves, and should reflect their interests.

2. It is correct to say that a unit is successful to

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[45] Smith, pp. 673-674.

[46] Buchanan, p. 29.

the degree that it involves careful development on the basis of the children's interests.

3. Although the teacher is undoubtedly the most influential member of any class, when she begins to dictate what shall be done, and how, much value is lost.

4. The children should have ample opportunity to exercise their initiative, and should be encouraged to follow their leads; it is better to permit them to make mistakes than to reduce the work to formal procedure that will require the children to act at the teacher's bidding.

5. The problem unit should deal with a situation closely related to one or more of the community's vital interests, but it must be developed on the basis of the pupils' interests.[47]

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[47]Wilson, Stone, and Dalrymple, pp. 315-317.

CHAPTER III

PUPIL PROGRESS UNDER THE FORMAL PROCEDURE

Intelligence Quotients and Chronological Ages

In addition to the determination of pupil progress in arithmetic by means of administering the tests previously referred to, the writer was interested in obtaining certain personal data relating to the pupils; for it was believed that such information would prove of value in the development of the major portion of her study, which was concerned with pupil progress under the formal or conventional method of teaching and under the activity set-up in seventh-grade arithmetic. Among these personal data were such items as chronological age and intelligence rating, as determined by standard tests devised for ascertaining intelligence quotients.

The investigator obtained from the pupils themselves information regarding chronological age, and from the files in the school office she was able to ascertain the intelligence quotient of each pupil, recorded during the preceding year when the pupils had been given intelligence tests upon entering the sixth grade in the Denton Junior High School.

Table 1 is a compilation of chronological ages and intelligence quotients for the thirty-five pupils enrolled in

TABLE 1

THE CHRONOLOGICAL AGES AND INTELLIGENCE QUOTIENTS OF THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS

Pupil Number	Chronological Ages		Intelligence Quotients	
	Boys	Girls	Boys	Girls
1....	10 - 7	15 - 11	102.4	78
2....	10 - 1	12 - 2	103	106
3....	11 - 0	11 - 1	105	108
4....	11 - 6	13 - 0	104	95
5....	11 - 0	11 - 10	108	105
6....	12 - 0	10 - 3	87	101
7....	12 - 0	12 - 0	97	103
8....	11 - 8	10 - 2	99	119
9....	12 - 8	10 - 6	112	111
10....	10 - 5	11 - 4	86	95
11....	11 - 8	11 - 2	114	111
12....	11 - 0	11 - 4	97	101
13....	12 - 1	10 - 11	96	97
14....	11 - 1	14 - 2	106	105
15....	11 - 0	11 - 1	100	112
16....	11 - 2	10 - 10	99	115
17....	12 - 9	10 - 5	108	107
18....	10 - 7	...	114	...
Total.	2,451	2,377	1,837.4	1,769
Median	11.35	11.65	102.78	104

the writer's conventional class in seventh-grade arithmetic. Data are presented on the basis of sex, and are arranged in parallel columns. This format of the table permits ready comparison of data for boys and for girls. The pupils were numbered, more or less arbitrarily, to provide a means of convenient identification and comparison. The pupil numbers appearing in tabulations in this chapter and in the one following have been employed consistently; that is, boy number one is the same individual in all cases, and the same is true of girl number one and of all other pupils in the class.

Chronological ages are shown in years and months in the table, the number to the left of the hyphen in the column representing the pupil's age in years and the number to the right, additional months. For example, the entry for boy number one is "10 - 7," or ten years and seven months. The average chronological age indicated only a negligible variation on the basis of sex, the average for boys being 11.35 years and that for girls, 11.65 years.

Intelligence quotients for the class ranged from a low of seventy-eight to a high of 119, the average for the boys being 102.78 and that for the girls, 104. This computation of averages indicates a slightly higher intelligence quotient for the girls, an average of 1.22 points, to be exact. The ten highest intelligence quotients, listed in descending order, are as follows: 119, 115, 114, 114, 112, 112, 111, 111, 108, 108. Represented in this group are six girls and four boys. Six boys and four girls are among the ten pupils having the lowest intelligence quotients, listed as follows in ascending order: seventy-eight, eighty-six, eighty-seven, ninety-five, ninety-five, ninety-six, ninety-seven, ninety-seven, ninety-seven, ninety-nine. A careful comparison of chronological ages and intelligence quotients indicates that, in this group of thirty-five pupils, no apparent relationship exists between age and intelligence. The averages, however, show a slight difference in favor of the girls for both age and intelligence; but the difference is so slight that the writer does not feel confident in saying that the older pupils had, on the average, a higher intelligence quotient.

Later in the study an attempt will be made to determine whether any relationship existed between the pupils' intelligence quotients and their ability to make high scores on the seven tests submitted to them for ascertaining their growth in seventh-grade arithmetic. The tabulations for this particular problem appear in Table 17 in Chapter V.

Progress in Number Comparison

Table 2 is a compilation of the results obtained when pupils enrolled in the conventional seventh-grade arithmetic class were given the Speer-Smith test on number comparisons, devised to indicate pupils' efficiency in mathematical reasoning. The "first test" indicated in the table was submitted to the class in September, 1940, and the "second test" was given in January, 1941. Both tests cover identical subject matter, although specific items are different. Each test contains ten items, each of which counts one point in the scoring; hence the highest possible score for this test

TABLE 2

THE SCORES[a] MADE ON THE TESTS ON NUMBER COMPARISON BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1......	9	6	9	7		1		
2......	10	10	10	10				
3......	10	10	10	10				
4......	10	8	10	9		1		
5......	10	10	10	10				
6......	7	9	7	9				
7......	8	10	8	10				
8......	8	10	9	10	1			
9......	10	10	10	10				
10......	7	8	6	9		1	1	
11......	10	10	10	10				
12......	9	9	10	10	1	1		
13......	8	8	9	9	1	1		
14......	10	8	10	9		1		
15......	10	10	10	10				
16......	9	10	10	10	1			
17......	10	10	10	10				
18......	10	..	10	..				
Total...	165	156	168	162	4	6	1	0
Median..	9.16	9.17	9.33	9.53	.22	.35	.05	0

[a]A score of ten points is a perfect score for this test.

is ten points. For the first test the boys' scores ranged from seven to ten points, and the same range is noted for the second test, although the eighteen boys gained a total of four points -- an average gain of .22 of a point. For the first test the girls' scores ranged from six to ten points, and for the second test, from seven to ten points, with a total gain of six points, or an average gain of .35 of a point for each of the seventeen girls. Only one point was lost by the boys, and none was lost by the girls. The average score for both boys and girls for both tests was less than one point below a perfect score. In the second test, however, the girls had an average of .13 of a point above that of the boys.

Progress in Problem Analysis

The second section of the tests administered to the pupils in September and in January dealt with proficiency in the analysis of problems in arithmetic. The scores for these tests appear in Table 3, together with gains and losses in points.

In this test, twenty points is a perfect score. In the first test no one made a perfect score, although one boy and two girls made scores of nineteen points. In the second test two boys and one girl made perfect scores. Whereas the eighteen boys gained twelve points (an average gain of .66 of a point per boy), the seventeen girls gained ten points (an

TABLE 3

THE SCORES[a] MADE ON THE TESTS ON PROBLEM ANALYSIS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	17	10	18	11	1	1		
2....	18	18	18	19		1		
3....	18	18	19	19	1	1		
4....	17	15	17	16		1		
5....	18	17	18	18		1		
6....	12	17	13	18	1	1		
7....	14	18	14	18				
8....	15	18	16	19	1	1		
9....	19	19	20	20	1	1		
10....	12	15	11	15			1	
11....	19	19	20	19	1			
12....	16	17	17	18	1	1		
13....	15	14	15	14				
14....	17	14	18	15	1	1		
15....	15	19	16	19	1			
16....	15	18	15	18				
17....	16	18	17	17	1			1
18....	17	..	19	..	2			
Total.	290	284	301	293	12	10	1	1
Median	16.11	16.70	16.72	17.23	.66	.58	.05	.05

[a]A score of twenty points is a perfect score for this test.

average gain of .58 of a point per girl). One boy and one girl lost one point each in the second test. Although both boys and girls made perceptible gains in problem analysis, the boys maintained a slightly higher average gain of .08 of a point.

Progress in Finding Keys to Problems

The third division of the tests submitted to the pupils pertained to ability to discover keys in the statement of problems that facilitate their solution. Here again the perfect score was ten points. In the first test no one attained a perfect score, although one boy and one girl made a score of nine points; in the second test, however, three boys made perfect scores and nine girls made scores of nine points. In no instance was the average score for either group as much as three points below the perfect score. In the second test the boys made a singular gain of eighteen points, or an average of one point for each of the eighteen boys. The seventeen girls, on the other hand, gained a total of twelve points, or an average of .70 of a point for each individual girl. Hence, in ability to discover keys to problems, the boys surpassed the girls in rate of progress by .30 of a point, One boy registered a one-point loss, but no losses were recorded for the girls. The tabulations from which these analyses are made appear in Table 4.

TABLE 4

THE SCORES[a] MADE ON THE TESTS ON FINDING KEYS TO ARITHMETIC PROBLEMS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	7	4	9	4	2			
2....	8	8	8	8				
3....	8	8	9	8	1			
4....	8	7	9	7	1			
5....	7	8	7	9		1		
6....	4	7	5	9	1	2		
7....	7	8	8	9	1	1		
8....	7	8	9	9	2	1		
9....	8	8	10	9	2	1		
10....	6	7	7	8	1	1		
11....	9	8	10	9	1	1		
12....	7	8	7	8				
13....	7	7	7	8		1		
14....	8	7	9	8	1	1		
15....	7	8	6	9		1	1	
16....	6	9	7	9	1			
17....	6	8	7	9	1	1		
18....	7	..	10	..	3			
Total.	127	128	144	140	18	12	1	0
Median	7.05	7.52	8.00	8.23	1.00	.70	.05	0

[a]A score of ten points is a perfect score for this test.

Progress in Solving Problems

Table 5 presents scores made on the fourth division of the Speer-Smith tests by the thirty-five pupils enrolled in the conventional class in seventh-grade arithmetic. This section of the test dealt with the solution of ten problems, each of which counted one point. Hence the perfect score for this test was ten points. No one made a perfect score on the first submission of the test, and one girl was the only pupil who made a score of nine points. On the second submission, however, one girl made a perfect score, and six girls and four boys made scores of nine points. On the second test the eighteen boys made a total gain of thirteen points, or an average of .72 of a point for each boy; and the seventeen girls made a total gain of fourteen points, or an average of .82 of a point for each girl. Hence, although the girls recorded two one-point losses and the boys, one one-point loss, the average gain for each girl was .10 of a point above the average gain for each boy.

TABLE 5

THE SCORES[a] MADE ON THE TESTS ON SOLVING PROBLEMS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	5	3	9	4	4	1		
2....	8	7	8	8		1		
3....	7	8	7	9		1		
4....	7	5	7	5				
5....	7	6	8	7	1	1		
6....	4	6	5	9	1	3		
7....	5	8	5	9		1		
8....	5	9	6	10	1	1		
9....	8	8	9	9	1	1		
10....	5	5	4	5			1	
11....	8	8	9	9	1	1		
12....	5	7	5	6				1
13....	5	5	5	6		1		
14....	6	5	6	6		1		
15....	5	8	6	8	1			
16....	5	8	6	9	1	1		
17....	6	8	7	7	1			1
18....	8	..	9	..	1			
Total.	109	114	121	126	13	14	1	2
Median	6.05	6.70	6.72	7.41	.72	.82	.05	.11

[a]A score of ten points is a perfect score for this test.

Progress in Fundamental Processes

The fifth section of the tests had to do with fundamental processes in arithmetic, and contained fifteen items, each of which counted one point in the scoring. Hence a perfect score for this test was fifteen points. Table 6 presents the results of the testing among the thirty-five members of the conventional class in seventh-grade arithmetic. Six boys and two girls made perfect scores on the first submission of the test; but on the second test, eight boys and eight girls made perfect scores. In no instance was the average score for either group as much as two points below the perfect score. Neither boys nor girls lost any points in the second test. The eighteen boys gained a total of ten points, representing an average gain per individual of .55 of a point. The seventeen girls, on the other hand, gained a total of eleven points which, when reduced to averages, indicated a gain per girl of .64 of a point. Hence, for this particular test, the average gain for the girls surpassed that of the boys by .09 of a point.

TABLE 6

THE SCORES[a] MADE ON THE TESTS ON FUNDAMENTAL PROCESSES BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	13	8	14	9	1	1		
2....	14	14	14	14				
3....	14	14	15	15	1	1		
4....	14	13	14	14		1		
5....	15	14	15	14				
6....	10	14	12	14	2			
7....	12	13	13	15	1	2		
8....	13	15	13	15				
9....	15	14	15	15		1		
10....	10	13	12	14	2	1		
11....	15	14	15	14				
12....	13	13	14	14	1	1		
13....	12	13	13	13	1			
14....	14	14	15	15	1	1		
15....	15	14	15	15		1		
16....	13	15	13	15				
17....	15	14	15	15		1		
18....	15	..	15	..				
Total.	242	229	252	240	10	11	0	0
Median	13.44	13.47	14.00	14.11	.55	.64	0	0

[a]A score of fifteen points is a perfect score for this test.

Progress in Fundamental Number Comparisons

The sixth portion of the tests likewise included fifteen items which counted one point each in the scoring. Fundamental number comparisons comprised the subject matter of this test, the scores for which are shown in Table 7, as applying to the thirty-five pupils enrolled in the conventional class in seventh-grade arithmetic.

In the first test five boys and five girls made perfect scores, but in the second test the number making perfect scores rose to eight boys and eight girls. For both boys and girls, for both tests, the average score was never as much as two points below the perfect score. One boy and one girl each made a one-point loss in the second submission of the test, and the gains were almost equal. The eighteen boys made a total gain of eight points, representing an average gain per pupil of .44 of a point, whereas the seventeen girls made a total gain of seven points, which made an average gain per pupil of .41 of a point. Thus it is readily seen that the average gains of the boys for this test surpassed those of the girls by only .03 of a point.

TABLE 7

THE SCORES[a] MADE ON THE TESTS ON FUNDAMENTAL NUMBER COMPARISONS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	13	9	14	9	1			
2....	14	14	14	13				1
3....	15	14	15	14				
4....	13	13	14	14	1	1		
5....	14	14	15	14	1			
6....	11	14	12	15	1	1		
7....	13	14	14	15	1	1		
8....	13	15	13	15				
9....	15	15	15	15				
10....	11	13	11	14		1		
11....	14	13	15	14	1	1		
12....	14	14	14	14				
13....	13	13	12	14		1	1	
14....	14	14	15	15	1	1		
15....	15	15	15	15				
16....	13	15	14	15	1			
17....	15	15	15	15				
18....	15	..	15	..				
Total.	245	234	252	240	8	7	1	1
Median	13.61	13.76	14.00	14.11	.44	.41	.05	.05

[a]A score of fifteen points is a perfect score for this test.

Progress in Arithmetic Fundamentals

The seventh and last section of the arithmetic tests submitted by the writer to her pupils was by far the longest division in the testing procedure utilized in carrying on this study. This section contained seventy items consisting of problems, each of which counted one point in the scoring. Hence a perfect score was seventy points. In no instance, in either the first or the second test, was a perfect score made. In the first test the scores ranged from fifty-five to sixty-eight for the boys and from fifty to sixty-eight for the girls; in the second test the range in scores was from fifty-six to sixty-nine for the boys and from forty-nine to sixty-nine for the girls. In no instance was the average score for either boys or girls as much as eight points below the perfect score, as shown in Table 8. One boy and one girl each lost one point in the second test. The gains, however, were relatively high. The eighteen boys made a total gain of fifteen points, or an average of .83 of a point for each boy; and the girls, seventeen in number, made a high gain of twenty-three points, or an average of 1.35 points per girl. Hence the average gains of the girls surpassed those of the boys by .52 of a point, the widest variation noted in any of the tests submitted to the conventional class.

TABLE 8

THE SCORES[a] MADE ON THE TESTS ON ARITHMETIC FUNDAMENTALS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE CONVENTIONAL SEVENTH-GRADE ARITHMETIC CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	61	50	62	49	1			1
2....	61	61	61	62		1		
3....	61	62	62	64	1	2		
4....	63	61	64	63	1	2		
5....	64	63	64	64		1		
6....	55	62	56	63	1	1		
7....	59	63	60	63	1			
8....	59	67	60	69	1	2		
9....	67	64	68	65	1	1		
10....	55	60	56	60	1			
11....	68	66	69	68	1	2		
12....	63	63	64	65	1	2		
13....	63	61	64	61	1			
14....	66	65	65	68		3	1	
15....	66	67	67	69	1	2		
16....	65	68	65	69		1		
17....	67	65	68	68	1	3		
18....	66	..	68	..	2			
Total.	1129	1068	1143	1090	15	23	1	1
Median	62.72	62.82	63.50	64.11	.83	1.35	.05	.05

[a]A score of seventy points is a perfect score for this test.

Summary

In summarizing the data presented in the foregoing pages of this chapter, the writer believes that the following general statements will serve to point out the principal findings with relation to pupil progress in the conventional class in seventh-grade arithmetic, viewed from the standpoint of the seven tests submitted to the pupils in the group:

1. The average age of the girls was slightly higher than that of the boys, and their average intelligence quotient was slightly higher, but the differences were not so pronounced as to indicate any definite relationship between age and intelligence.

2. In all seven of the tests, appreciable gains were made by both boys and girls when they took the tests for the second time. The losses in points were so few as to be almost negligible, and for this reason have not been included in the analyses presented in this chapter, although they are shown distinctly in the tables.

3. In the test on number comparison the girls had an average gain in score of .13 of a point above that of the boys.

4. With respect to problem analysis, the boys surpassed the girls in points gained in the second test, to the extent of an average gain of .08 of a point.

5. In ability to discover keys to arithmetic problems,

the boys surpassed the girls in their rate of gain by .30 of a point.

6. In the solution of problems, however, the girls showed the greater gain in progress, averaging .10 of a point above the gain recorded for the boys.

7. In the case of fundamental processes, the progress of the girls was likewise more perceptible than that of the boys, for the girls' average gain was .09 of a point above that recorded for the boys.

8. With relation to fundamental number comparisons, the boys showed a slightly more progressive score than the girls, their average gain exceeding that of the girls by .03 of a point.

9. The highest rate of progress recorded among the pupils of the conventional class occurred in connection with the test on arithmetic fundamentals, in which the average gain of the girls surpassed that of the boys by .52 of a point.

10. In four of the seven tests given to the conventional class, the girls showed more progress than did the boys, whereas in the remaining three tests the boys exceeded the girls in points gained.

CHAPTER IV

PUPIL PROGRESS UNDER THE ACTIVITY PROCEDURE

The writer has mentioned in the first chapter of this thesis the fact that a store project constituted the principal phase of work for the pupils enrolled in the activity class in seventh-grade arithmetic. She has also referred to the fact that two other minor projects were given some consideration by this group of pupils during the semester, namely, units on hobbies and transportation. In the development of the first-mentioned project, the pupils were encouraged to name hobbies in which they were particularly interested. Those that afforded opportunity for the application of mathematics were emphasized in the class, and a general discussion revealed the ways in which arithmetic contributed to the enjoyment of the hobbies under consideration. A few pupils worked out problems on their personal hobbies, with the result that a miniature house was built by one group of pupils, while others worked out scale drawings of plans for the house and for a city. More pupils were interested in various phases of transportation than in any other one type of hobby, hence a number of pupils co-operated in building models of airplanes, automobiles, trains, and ships. All of these projects, of course, involved careful mathematical calculations of various kinds that enabled the children to understand more clearly the role played by arithmetic in the common things of everyday life. It should be pointed out that the pupils who engaged in work on hobbies and transportation were, at the same time, assisting in the store project, which was carried on throughout the semester. Because of the overlapping of personnel in all of the projects, and because of the relatively greater significance of the store unit, the writer administered her tests to the activity class as a whole, and in her tabulations did not find it possible to obtain separate scores for those engaged in hobbies and transportation and for those who were working in the store. In fact, the same children were, at one time or another, doing work in both undertakings. For these reasons, which the writer believed should be explained at this point, the tabulations for the activity group of pupils refer to the store project which has previously been explained in detail.

Intelligence Quotients and Chronological Ages

In the same manner as has been described for the pupils in the conventional class in seventh-grade arithmetic, the writer obtained certain personal data relating to the pupils enrolled in the activity class. Here, as in the former case, chronological ages were obtained from the children themselves, whereas the intelligence quotients were taken from the records of the school office. Table 9 presents the chronological ages and the intelligence quotients of the thirty-five pupils in the activity class, arranged in the manner that has already been described for the pupils enrolled in the formal class.

As shown in the table, there was little difference in the chronological ages of the boys and girls taken as a whole. Of course, there were wide individual variations, but the average age of the boys and girls was, respectively, 13.92 and 13.36 years. In intelligence, however, the boys surpassed the girls, the average intelligence quotients being, respectively, 104.17 and 96.65 -- a difference of 7.52 points in favor of the boys. The ten highest intelligence quotients, listed in descending order, were as follows: 122, 122, 120, 119, 118, 118, 111, 110, 110, 108. Eight boys and two girls were represented in these ten highest intelligence scores. On the other hand, six girls and four boys appeared in the list of the ten lowest intelligence quotients, which are here arranged in the order of their increase: eighty-six, eighty-seven, eighty-eight, eighty-eight, eighty-nine, eighty-nine, eighty-nine, ninety, ninety, ninety-one.

Here, as in the tabulations for the conventional class, the group which is slightly older has the higher average

TABLE 9

THE CHRONOLOGICAL AGES AND INTELLIGENCE QUOTIENTS OF THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS

Pupil Number	Chronological Ages		Intelligence Quotients	
	Boys	Girls	Boys	Girls
1....	10 - 1	11 - 4	119	108
2....	11 - 10	11 - 5	89	98
3....	11 - 9	11 - 9	95	92
4....	12 - 3	12 - 0	96	98
5....	11 - 2	11 - 2	98	102
6....	10 - 6	11 - 4	110	103
7....	12 - 2	12 - 3	88	87
8....	12 - 0	12 - 0	120	100
9....	12 - 0	11 - 7	89	91
10....	11 - 8	11 - 0	90	89
11....	11 - 7	11 - 8	101	96
12....	10 - 11	11 - 9	111	96
13....	11 - 3	12 - 0	94	118
14....	11 - 5	12 - 9	110	86
15....	12 - 1	12 - 0	93	88
16....	12 - 0	11 - 9	122	90
17....	12 - 0	11 - 8	118	101
18....	12 - 2	...	122	...
Total.	2,505	2,272	1,875	1,643
Median	13.92	13.36	104.17	96.65

intelligence quotient, but the writer does not consider that even this coincidence warrants a definite conclusion in the matter.

Progress in Number Comparison

Identically the same tests were administered to the activity class as were given to the formal class, and the results will be presented in this chapter for the activity group in the same order and manner that were employed in the preceding chapter for indicating data pertaining to the formal group. In keeping with this plan, Table 10 shows the scores made on the number comparison test by the eighteen boys and the seventeen girls enrolled in the class that conducted the store project.

On the first test three boys made a perfect score of ten points, but no girls made a perfect score, although six made scores of nine points. On the second test, however, five boys and two girls made perfect scores. In only one instance was the average score more than two points below the perfect score. A one-point loss was recorded for the girls, but no losses were made by the boys. The eighteen boys made a total gain of eight points, or an average of .44 of a point for each boy. The seventeen girls, on the other hand, made a total gain of ten points, which amounted to an average of .58 of a point for each girl. Hence, in the test on number comparison, the girls made more progress

TABLE 10

THE SCORES[a] MADE ON THE TESTS ON NUMBER COMPARISON BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	9	9	10	9	1			
2....	7	7	7	8		1		
3....	8	7	8	7				
4....	8	9	9	8	1			1
5....	8	9	9	9	1			
6....	9	9	9	10		1		
7....	7	6	8	8	1	2		
8....	9	8	10	8	1			
9....	7	7	7	8		1		
10....	7	7	8	8	1	1		
11....	8	8	8	9		1		
12....	8	8	9	8	1			
13....	8	9	8	10		1		
14....	8	7	9	8	1	1		
15....	8	8	8	8				
16....	10	8	10	9		1		
17....	10	9	10	9				
18....	10	..	10	..				
Total.	149	135	157	144	8	10	0	1
Median	8.27	7.94	8.72	8.47	.44	.58	0	.05

[a]A score of ten points is a perfect score for this test.

than the boys, the girls' average gain exceeding the boys' by .14 of a point.

Progress in Problem Analysis

Table 11 shows the scores made on the problem analysis test by the eighteen boys and the seventeen girls enrolled in the activity class in seventh-grade arithmetic. In the first test only one boy made the perfect score of twenty points, whereas the highest score made by any girl was eighteen points. Strangely, in the second test, a perfect score was made by only one individual -- the boy who had made the highest possible score on the first test. However, on the second test, three boys and three girls made a score of nineteen points. For both tests, for both boys and girls, the average score was in no instance as much as four points below the perfect score. A total of twelve points were gained by the eighteen boys in the second test, representing an average gain per boy of .66 of a point. The same number of points were gained by the seventeen girls, but in this instance the gain represented an average gain of .70 of a point for each individual girl. No losses were made by either the boys or the girls. The average gain of the girls exceeded that of the boys by .04 of a point.

TABLE 11

THE SCORES[a] MADE ON THE TESTS ON PROBLEM ANALYSIS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	17	17	19	19	2	2		
2....	15	16	16	17	1	1		
3....	16	16	16	16				
4....	16	16	16	17		1		
5....	16	17	17	18	1	1		
6....	17	18	18	18	1			
7....	15	15	16	15	1			
8....	17	17	19	18	2	1		
9....	15	16	16	17	1	1		
10....	16	16	16	16				
11....	16	17	17	17	1			
12....	17	17	17	17				
13....	16	17	17	19	1	2		
14....	17	16	17	16				
15....	16	16	16	17		1		
16....	18	17	19	18	1	1		
17....	18	18	18	19		1		
18....	20	..	20	..				
Total.	298	282	310	294	12	12	0	0
Median	16.55	16.58	17.22	17.29	.66	.70	0	0

[a]A score of twenty points is a perfect score for this test.

Progress in Finding Keys to Problems

The third division of the tests submitted to the activity class was on discovering keys to the solution of problems in arithmetic. In the first test, as shown in Table 12, two boys and two girls made a perfect score of ten points. When the test was submitted for the second time, five boys and three girls won perfect scores. The average score of any group on either of the tests was never as much as three points below the perfect score. In the second test the boys gained a total of nine points above their scores for the first test, which amounted to an average individual gain per boy of .50 of a point. The girls gained a total of seven points, or an average of .41 of a point per individual girl. Hence, in finding keys to problems in arithmetic, the boys showed more progress than did the girls, the average individual gain being .09 of a point in favor of the boys. No losses in points were made by either boys or girls when they took the second test.

TABLE 12

THE SCORES[a] MADE ON THE TESTS ON FINDING KEYS TO PROBLEMS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	9	9	10	9	1			
2...	5	7	6	7	1			
3...	7	7	7	7				
4...	7	8	7	9		1		
5...	7	9	8	9	1			
6...	8	9	9	10	1	1		
7...	5	6	5	7		1		
8...	9	10	10	10	1			
9...	6	8	6	8				
10...	7	7	7	8		1		
11...	8	8	9	8	1			
12...	9	8	9	9		1		
13...	7	10	8	10	1			
14...	9	7	9	8		1		
15...	8	7	9	7	1			
16...	10	8	10	8				
17...	9	8	10	9	1	1		
18...	10	..	10	..				
Total	140	136	149	143	9	7	0	0
Median	7.77	8.00	8.27	8.41	.50	.41	0	0

[a]A score of ten points is a perfect score for this test.

Progress in Solving Problems

Table 13 indicates that four boys and two girls made a perfect score of ten points when the test on the solution of arithmetic problems was first presented to them by the writer. When the test was given again, four months later, to the same pupils enrolled in the seventh-grade arithmetic activity class, five boys and eight girls made perfect scores. In neither test was the average score for either boys or girls as much as two points below the perfect score. In the second submission of the test the boys sustained two one-point losses, and the girls had one one-point loss. The eighteen boys made a total gain in the second test of seven points, or an average gain per boy of .39 of a point. The seventeen girls, on the other hand, gained a total of eleven points, which represented an average individual gain of .64 of a point. In the case of the solution of arithmetic problems, then, the girls made considerably more progress than did the boys, their average individual gain exceeding that of the boys by .25 of a point.

TABLE 13

THE SCORES[a] MADE ON THE TESTS ON SOLVING PROBLEMS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	10	10	10	10				
2....	6	8	6	8				
3....	7	7	8	8	1	1		
4....	7	7	7	9		2		
5....	8	8	8	10		2		
6....	8	9	9	10	1	1		
7....	5	7	6	7	1			
8....	9	9	10	10	1	1		
9....	6	8	5	9		1	1	
10....	7	9	8	9	1			
11....	8	9	8	9				
12....	9	9	9	10		1		
13....	8	10	8	10				
14....	9	7	10	6	1			1
15....	8	8	9	8	1			
16....	10	9	9	10		1	1	
17....	10	9	10	10		1		
18....	10	..	10	..				
Total.	145	143	150	153	7	11	2	1
Median	8.05	8.41	8.33	9.00	.39	.64	.11	.05

[a]A score of ten points is a perfect score for this test.

Progress in Fundamental Processes

The fifth division of the tests dealt with the fundamental processes in arithmetic that should be mastered by seventh-grade pupils. Table 14 presents the results of this testing among the thirty-five pupils in the activity class. Since the test contained fifteen items, each of which counted one point in the scoring, the perfect score was fifteen points. This score was made by three boys and three girls in the first submission of the test, and by six boys and six girls in the second submission. For neither test was the average score for either boys or girls as much as two points below the perfect score. No losses were made by either boys or girls when the test was submitted for the second time. The eighteen boys, however, gained a total of eleven points in the second test, representing an average gain of .61 of a point for each individual boy. The seventeen girls gained a total of ten points, amounting to an average individual gain of .58 of a point. Hence the average progress of the boys exceeded that of the girls by .03 of a point with respect to the fundamental processes that should be mastered by seventh-grade pupils.

TABLE 14

THE SCORES[a] MADE ON THE TESTS ON FUNDAMENTAL PROCESSES BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	14	15	14	15				
2....	11	14	12	14	1			
3....	12	14	13	15	1	1		
4....	12	14	13	15	1	1		
5....	12	15	14	15	2			
6....	14	15	15	15	1			
7....	11	13	11	13				
8....	14	14	15	14	1			
9....	12	13	12	14		1		
10....	12	13	13	14	1	1		
11....	13	14	14	14	1			
12....	14	13	14	14		1		
13....	13	14	14	15	1	1		
14....	14	11	15	13	1	2		
15....	13	12	13	13		1		
16....	15	13	15	14		1		
17....	15	14	15	14				
18....	15	..	15	..				
Total.	236	231	247	241	11	10	0	0
Median	13.11	13.58	13.72	14.17	.61	.58	0	0

[a]A score of fifteen points is a perfect score for this test.

Progress in Fundamental Number Comparisons

In Table 15 is presented information relating to the submission of the test on fundamental number comparisons to the pupils enrolled in the activity class in seventh-grade arithmetic. In this instance, as with the test discussed in the preceding paragraph, the perfect score was fifteen points. When the test was first submitted to the pupils in this group, three boys and two girls made perfect scores; but when it was submitted to the pupils for the second time, seven boys and six girls attained the highest possible score. The average score for neither boys nor girls was ever as much as two points below the perfect score. In the second submission of the test, the girls sustained two one-point losses, but the boys experienced no losses. Both boys and girls made total gains of eleven points, which represented an average individual gain for the boys and girls of .61 and .64 of a point, respectively. It is thus seen that the progress of the girls exceeded that of the boys by .03 of a point.

TABLE 15

THE SCORES[a] MADE ON THE TESTS ON FUNDAMENTAL NUMBER COMPARISONS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	14	15	15	15	1			
2....	12	14	12	13				1
3....	13	13	13	14		1		
4....	12	14	13	14	1			
5....	13	14	14	15	1	1		
6....	14	14	15	15	1	1		
7....	12	12	12	13		1		
8....	15	14	15	14				
9....	12	13	13	14	1	1		
10....	12	14	14	13	2			1
11....	13	14	14	15	1	1		
12....	14	14	15	14	1			
13....	13	15	13	15				
14....	14	11	14	12		1		
15....	13	12	14	13	1	1		
16....	15	12	15	14		2		
17....	14	14	15	15	1	1		
18....	15	..	15	..				
Total.	240	229	251	238	11	11	0	2
Median	13.33	13.47	13.94	14.00	.61	.64	0	.11

[a]A score of fifteen points is a perfect score for this test.

Progress in Arithmetic Fundamentals

Table 16 shows scores for the boys and girls in the activity class when they took the lengthy test on arithmetic fundamentals for the first and second times. This test had seventy items, each of which counted one point; hence the perfect score was seventy points. No one made a perfect score on the first test, and only one boy did so in the second test. On the first test the scores ranged from fifty-six to sixty-nine for the boys and from fifty-five to sixty-nine for the girls. On the second test the range was from fifty-six to seventy for the boys and from fifty-six to sixty-nine for the girls. Never was the average score as much as nine points below the perfect score. The eighteen boys gained a total of fourteen points, which accounted for an average gain of .77 of a point per individual boy. The girls, with a total gain of fifteen points, had an average individual gain of .88 of a point. It is apparent that the girls attained a higher degree of progress than did the boys, for the average individual gain of the girls exceeded that of the boys by .11 of a point. Although the girls suffered a one-point loss in the second test, no losses at all were recorded for the boys.

TABLE 16

THE SCORES[a] MADE ON THE TESTS ON ARITHMETIC FUNDAMENTALS BY THE EIGHTEEN BOYS AND THE SEVENTEEN GIRLS ENROLLED IN THE SEVENTH-GRADE ARITHMETIC ACTIVITY CLASS, SHOWING GAINS AND LOSSES IN POINTS

Pupil Number	Scores for First Test		Scores for Second Test		Gains		Losses	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1....	62	67	63	68	1	1		
2....	56	59	57	61	1	2		
3....	59	59	60	60	1	1		
4....	59	60	60	61	1	1		
5....	60	61	60	63		2		
6....	62	62	63	63	1	1		
7....	56	55	56	56		1		
8....	65	66	66	65	1			1
9....	56	65	57	66	1	1		
10....	59	64	60	65	1	1		
11....	60	65	61	66	1	1		
12....	61	66	62	66	1			
13....	60	69	60	69				
14....	62	57	63	57	1			
15....	60	66	61	66	1			
16....	68	61	69	62	1	1		
17....	68	66	68	68		2		
18....	69	..	70	..	1			
Total.	1102	1068	1116	1082	14	15	0	1
Median	61.22	62.82	62.00	63.64	.77	.88	0	.05

[a]A score of seventy points is a perfect score for this test.

Summary

As in the case of the analysis of tests submitted to pupils in the conventional class in seventh-grade arithmetic, the writer believes that a few summary statements in the present instance will serve to point out the principal findings in connection with the tests submitted to the activity group in seventh-grade arithmetic. These statements follow:

1. On the whole, there was little difference in the chronological ages of the boys and the girls in the group. When averages were taken, however, it was discovered that the boys were slightly older than the girls, and that they had a somewhat higher average intelligence quotient. In the conventional class, a similar situation was found in the case of the girls. In both instances, however, the differences appear to be too insignificant to support any definite conclusion as to a relationship between age and intelligence.

2. In the activity class perceptible progress was made by both boys and girls in all seven of the tests submitted.

3. In the test on number comparison, the girls' average gain exceeded that of the boys by .14 of a point.

4. With relation to problem analysis, the girls' average progress was .04 of a point above that of the boys.

5. The boys, however, showed a slight lead over the girls in the case of finding keys to arithmetic problems, the difference in individual gain being .09 of a point in favor of the boys.

6. In the solution of problems, though, the girls were once more in the lead with an individual gain that exceeded that of the boys by .25 of a point.

7. In the test on fundamental processes the boys averaged .03 of a point lead over the girls.

8. In the case of fundamental number comparisons, the progress of the girls exceeded that of the boys by an average of .03 of a point.

9. In connection with arithmetic fundamentals, the girls likewise attained a higher degree of progress than did the boys, for the average individual gain of the girls exceeded that of the boys by .11 of a point.

10. In five of the seven tests submitted to the class that carried on the store project, the girls attained more progress than did the boys.

CHAPTER V

ANALYSIS OF PUPIL PROGRESS UNDER THE TWO PROCEDURES

In the third chapter of this thesis were presented in tabular form the results of the submission of the seven sections of the Speer-Smith tests in arithmetic reasoning and fundamentals to pupils in the conventional seventh-grade arithmetic class. These tests, as has been explained previously, are available in two different issues known as Form A and Form B. The seven divisions that form the basis of the present study are found in both forms, and include precisely the same subject matter, but with variation in specific items. Form A of both tests was submitted to the members of both the conventional and the activity classes at the beginning of the semester in September, 1940; Form B was given to the same pupils near the close of the semester in January, 1941. The fourth chapter contains an analysis of similar data resulting from the submission of the same tests to pupils enrolled in the writer's activity class in seventh-grade arithmetic. For both groups, individual scores were presented for the first and second tests, and average or median scores were computed. Likewise were shown the number of points gained or lost in the individual scores for the second test in comparison with the scores for the first test. These tabulations have been made for both boys and girls in the two classes and have been arranged in such a way as to facilitate comparisons.

The present chapter is designed to include a concise summary and comparison of the findings appearing in the two preceding chapters, and contains an analysis of the progress made on the seven tests by pupils in the conventional class and in the activity class in seventh-grade arithmetic.

Pupil Progress on the Basis of Intelligence Quotients

One of the significant studies that can be made on the basis of the findings resulting from this investigation is an analysis of pupil progress as influenced by intelligence. For the accomplishment of this object the writer believed that the most expedient method would entail a classification of the pupils as to highest and lowest intelligence quotients. She decided that, if any conclusions should be warranted with respect to the relationship between intelligence and the test scores, they likely would be more apparent if scores were compared for the ten highest and the ten lowest intelligence quotients in each class than if the entire class personnel should be included in the analysis. Because of this decision, the writer has made tabulations of scores of the seven tests for the ten pupils in both classes with the highest intelligence quotients and for the ten pupils in both classes with the lowest intelligence quotients. In each class this technique of analysis leaves a middle group of fifteen pupils who do not figure at all in the calculations. It is believed, however, that this fact will be an advantage to the proposed comparison, rather than a handicap.

Before proceeding with the analysis of pupil progress in terms of intelligence, the writer feels that she should make at this point a brief explanation of the method in which the tabulations have been organized and treated. Table 17 shows the scores made on the seven arithmetic tests by the ten pupils in both the conventional class and the activity class who had the highest intelligence quotients. Table 18 performs the same function for the ten pupils in each of the two classes who had the lowest intelligence quotients. The intelligence quotients have been arranged in descending and ascending order, respectively, for the ten highest and the ten lowest, and have been assigned "I. Q. Rank" numbers in keeping with this arrangement. That is, in the highest-intelligence group, I. Q. rank one designates the pupil with the highest intelligence, I. Q. rank two identifies the pupil with the second highest intelligence, and so on to the tenth highest; in a similar manner, I. Q. rank one in the lowest-intelligence group indicates the pupil with the lowest intelligence, I. Q. rank two, the one with the second lowest, and so on to the tenth lowest.

For convenience, the writer has substituted Roman numerals for the titles of the seven tests submitted to the classes. These numerals appear in Tables 17 and 18 and designate the tests in the same order as that in which they have been discussed in the two preceding chapters. That is, they represent the tests as follows: I, number comparison; II, problem analysis; III, finding keys to problems; IV, solving problems; V, fundamental processes; VI, fundamental number comparisons; and VII, arithmetic fundamentals. The Arabic numerals "1" and "2" designate, respectively, the first and second submissions of the tests. The numbers appearing throughout the "Average Score" columns of both tables were arrived at by adding the scores for the two submissions of all seven of the tests and dividing the sum by fourteen, the total number of test scores in each case.

An examination of the scores recorded for Test I reveals at once that whereas all scores in the highest-intelligence group were perfect scores in the conventional class, only one perfect score appears in the tabulations for the lowest-intelligence group of the same class. There are, however, six scores of nine points in this group. The pupils with the highest intelligence have three perfect scores recorded for Test II, whereas the lowest-intelligence group has no perfect score, and one score of seventeen points, three points below the perfect score, is their nearest approach to perfection. For Test III, the highest-intelligence group received three perfect scores, but no one in the lowest-intelligence bracket made a perfect score, and only one pupil received a score of nine points. As shown in Tables 17 and 18 for Test IV, only one pupil, the one who had the highest intelligence quotient in the conventional class, has a perfect score: and two scores of six points each, four points below the perfect score, represent the lowest-intelligence group's nearest approach to perfection. Test V shows fifteen perfect scores among the pupils in the conventional class who had the highest intelligence quotients and none among those with the lowest intelligence quotients, although three scores are recorded, each of which is only one point below perfection. For Test VI a similar result is shown. Fourteen perfect scores are recorded for the highest-intelligence group and none for the lowest, although six pupils have scores that are only one point below perfection. In Test VII no one made a perfect score, although four pupils in the highest-intelligence group have scores only one point below perfection. In the lowest-intelligence group, however, two scores that are six points below perfection are the highest recorded for the group. The average scores for the conventional class range from 19.4 to 20.7 for the pupils with the highest intelligence and from 13.7 to 18.4 for those with the lowest intelligence. A simple calculation based upon the average scores appearing in the tables discloses that the

TABLE 17

THE SCORES MADE ON THE SEVEN TESTS ADMINISTERED IN SEPTEMBER AND IN JANUARY BY THE TEN PUPILS IN THE CONVENTIONAL AND ACTIVITY CLASSES IN SEVENTH-GRADE ARITHMETIC WHO HAD THE HIGHEST INTELLIGENCE QUOTIENTS

I. Q. Rank	I. Q.	Tests														Average Score
		I		II		III		IV		V		VI		VII		
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	
The Conventional Class																
1...	119	10	10	18	19	8	9	9	10	15	15	15	15	67	69	20.6
2...	115	10	10	18	18	9	9	8	9	15	15	15	15	68	69	20.5
3...	114	10	10	19	20	9	10	8	9	15	15	14	15	68	69	20.7
4...	114	10	10	17	19	7	10	8	9	15	15	15	15	66	68	20.2
5...	112	10	10	19	19	8	9	8	8	14	15	15	15	67	69	20.4
6...	112	10	10	19	20	8	10	8	9	15	15	15	15	67	68	20.6
7...	111	10	10	19	20	8	9	8	9	14	15	15	15	64	65	20.0
8...	111	10	10	19	19	8	9	8	9	14	14	13	14	66	68	20.0
9...	108	10	10	18	18	7	7	7	8	15	15	14	15	64	64	19.4
10...	108	10	10	18	19	8	8	8	9	14	15	14	14	62	64	19.5
The Activity Class																
1...	122	10	10	18	19	10	10	10	9	15	15	15	15	68	69	20.9
2...	122	10	10	20	20	10	10	10	10	15	15	15	15	69	70	21.3
3...	120	9	10	17	19	9	10	9	10	14	15	15	15	65	66	20.2
4...	119	9	10	17	19	9	10	10	10	14	14	14	15	62	63	19.7
5...	118	10	10	18	18	9	10	10	10	15	15	14	15	68	68	20.7
6...	118	9	10	17	19	10	10	10	10	14	15	15	15	69	69	20.8
7...	111	8	9	17	17	9	9	9	9	14	14	14	15	61	62	19.0
8...	110	9	9	17	18	8	9	8	9	14	15	14	15	62	63	19.2
9...	110	8	9	17	17	9	9	9	10	14	15	14	14	62	63	19.2
10...	108	9	9	17	19	9	9	10	10	15	15	15	15	67	68	20.5

TABLE 18

THE SCORES MADE ON THE SEVEN TESTS ADMINISTERED IN SEPTEMBER AND IN JANUARY BY THE TEN PUPILS IN THE CONVENTIONAL AND ACTIVITY CLASSES IN SEVENTH-GRADE ARITHMETIC WHO HAD THE LOWEST INTELLIGENCE QUOTIENTS

I. Q. Rank	I. Q.	Tests														Average Score
		I		II		III		IV		V		VI		VII		
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	
The Conventional Class																
1...	78	6	7	10	11	4	4	3	4	8	9	9	9	50	49	13.7
2...	86	7	6	12	11	6	7	5	4	10	12	11	11	55	56	15.2
3...	87	7	7	12	13	4	5	4	5	10	12	11	12	55	56	15.2
4...	95	8	9	15	16	7	7	5	5	13	14	13	14	61	63	17.1
5...	95	8	9	15	15	7	8	5	5	13	14	13	14	60	60	17.5
6...	96	8	9	15	15	7	7	5	5	12	13	13	12	63	64	17.7
7...	97	9	10	16	17	7	7	5	5	13	14	14	14	63	64	18.4
8...	97	8	9	14	14	7	8	5	6	13	13	13	14	61	61	17.5
9...	97	8	8	14	14	7	8	5	5	12	13	13	14	59	60	17.1
10...	99	8	9	15	16	7	9	5	6	13	13	13	13	59	60	17.5
The Activity Class																
1...	86	7	8	16	16	7	8	7	6	11	13	11	12	57	57	16.8
2...	87	6	8	15	15	6	7	7	7	13	13	12	13	55	56	16.6
3...	88	8	8	16	17	7	7	8	8	12	13	12	13	66	66	18.6
4...	88	7	8	15	16	5	5	5	6	11	11	12	12	56	56	16.0
5...	89	7	7	15	16	5	6	6	6	11	12	12	12	56	57	16.2
6...	89	7	7	15	16	6	6	6	5	12	12	12	13	56	57	15.7
7...	89	7	8	16	16	7	8	9	9	13	14	14	13	64	65	18.7
8...	90	7	8	16	16	7	7	7	8	12	13	12	14	59	60	17.5
9...	90	8	9	17	18	8	8	9	10	13	14	12	14	61	62	18.7
10...	91	7	8	16	17	8	8	8	9	13	14	13	14	65	66	20.1

average of the average scores is 20.1 and 16.6 for the highest and lowest intelligence groups, respectively. This means that, in the conventional class, the average of the average scores was 3.5 points higher for the highest-intelligence group than for the lowest-intelligence group. Though this difference is not striking, it doubtless is important as an index to a definite trend of relationship between intelligence and the scores made on the seven tests by the pupils in the conventional class in seventh-grade arithmetic.

As indicated in Tables 17 and 18, nine pupils in the activity class made a perfect score when the highest-intelligence group took Test I, whereas no one in the lowest-intelligence group made a perfect score, although one pupil approached it within one point. For Test II, two perfect scores of twenty points are recorded with the pupils having the highest intelligence, both occurrences being in the case of a pupil with the highest intelligence quotient in the class. One score of eighteen points was the nearest approach to perfection recorded among the pupils with the lowest intelligence quotients. In the case of Test III, nine perfect scores are shown by the highest-intelligence group, the same pupils, with one exception, making perfect scores in this test as in Test I. Among the lowest-intelligence pupils, however, six scores of eight points each represent the highest scores for the group. For Test IV, the pupils in the highest-intelligence bracket have thirteen perfect scores to their credit, whereas those with the lowest intelligence quotients have one perfect score. This, incidentally, is the only perfect score found among the lowest-intelligence group of the activity class. For Test V are recorded twelve perfect scores among the pupils of the highest-intelligence group. No perfect scores are listed for the pupils of lowest intelligence, although three have scores within one point of perfection. When the pupils of this class took Test VI, fourteen of those with highest intelligence made perfect scores of fifteen points, whereas four of those with lowest intelligence made scores that were only one point below perfection. One perfect score is recorded for the highest-intelligence group for Test VII, but one score that was four points below the perfect score is the highest found among the pupils with lowest intelligence quotients. In the average scores for the activity class, as shown in Tables 17 and 18, the range is from 19.0 to 21.3 for the pupils among the highest-intelligence group, and from 15.7 to 20.1 for the lowest-intelligence group. A simple calculation based upon these average scores reveals the fact that the average of the average scores is 20.1 for those pupils with highest intelligence and 17.4 for those with lowest intelligence. This means that, in the activity class, the average of the average scores was 2.7 points higher for the highest-intelligence group than for the lowest-intelligence group. Here, as in the case of the conventional class, there seems to be a perceptible relationship between intelligence and test scores.

Now that Tables 17 and 18 have been analyzed at length, the writer discovers certain interesting and significant comparisons that are indicated in the tables. In the first place, the average scores indicate that intelligence was a determining factor in the scores that were made on the tests in both classes by the pupils with the highest and those with the lowest intelligence quotients. In the second place, a careful comparison shows that, of the ten pupils in the highest-intelligence group of the activity class, five made average scores that were higher than those made by the corresponding pupils in the conventional class. In the lowest-intelligence group, however, seven of the ten pupils in the activity class had average scores higher than those of the corresponding pupils in the conventional class. These facts lead directly to the third notable comparison that should be pointed out, namely, the relation between the average scores made by the highest- and lowest-intelligence groups in the two classes. The average of the average scores reveals that no difference existed between the scores of the highest-intelligence group in the conventional class as compared with those in the activity class. The average of the average scores in each case was 20.1.

With regard to the lowest-intelligence group, however, a distinction was noted in favor of the activity class. Here the average of the average scores is 16.6 for the conventional class and 17.4 for the activity class -- a difference of .8 of a point in favor of the activity class. These facts imply a conclusion that the activity method of teaching is fully as conducive to progress in seventh-grade arithmetic as is the conventional procedure and, in certain instances, particularly among the less capable pupils, surpasses the formal technique of teaching in the degree to which it fosters pupil progress.

Comparison of Average Scores

For purposes of ready comparison, the writer has tabulated in Table 19 the average scores for the first and second submissions of the seven tests that formed the basis of this study. These averages were obtained from the tables appearing in the two preceding chapters, and are arranged in Table 19 in such a manner as to provide opportunity for comparing the results of the individual tests among both boys and girls of the conventional and the activity classes. Shown also in this table are the average scores for each test, which are in reality the average of the average scores; they were obtained by adding the average scores for the seven tests and dividing the sum by seven. The average scores throughout the table are based upon the scores made by the thirty-five pupils in each of the classes.

It will be discovered by examining the table that, in all cases except two, the average scores of the girls surpassed those of the boys, sometimes by several points and occasionally by only .01 of a point. The two exceptions to this general trend occur for the girls in the activity class in connection with the first test, that on number comparisons. In the main it is true that the girls in both classes made higher scores on all tests than did the boys.

In every instance both boys and girls in both classes made higher average scores on the second test than on the first. With only a few notable exceptions the table shows that the average scores for each test were higher for the activity class than for the corresponding submission of the test to the conventional class. This was true among both boys and girls. There are thirteen exceptions to this general trend, as follows: among the boys, the first and second submissions of the test on number comparisons, the second submission of the test on fundamental processes, the first and second submissions of the test on fundamental number comparisons, and the first and second submissions of the test on arithmetic fundamentals; and among the girls, the first and second submissions of the test on number comparison, the first submission of the test on problem analysis, the first and second submissions of the test on fundamental number comparisons, and the second submission of the test on arithmetic fundamentals.

TABLE 19

COMPARISON OF THE AVERAGE SCORES MADE ON THE SEVEN TESTS BY BOYS AND BY GIRLS IN THE CONVENTIONAL AND ACTIVITY CLASSES IN SEVENTH-GRADE ARITHMETIC

Tests	Average Scores in the Conventional Class		Average Scores in the Activity Class	
	First Test	Second Test	First Test	Second Test
Boys				
Number comparison.............	9.16	9.33	8.27	8.72
Problem analysis..............	16.11	16.72	16.55	17.22
Finding keys to problems......	7.05	8.00	7.77	8.27
Solving problems..............	6.05	6.72	8.05	8.33
Fundamental processes.........	13.44	14.00	13.11	13.72
Fundamental number comparisons	13.61	14.00	13.33	13.94
Arithmetic fundamentals.......	62.72	63.50	61.22	62.00
Average score for each test	16.87	18.89	18.32	18.88
Girls				
Number comparison.............	9.17	9.53	7.94	8.47
Problem analysis..............	16.70	17.23	16.58	17.29
Finding keys to problems......	7.52	8.23	8.00	8.41
Solving problems..............	6.70	7.41	8.41	9.00
Fundamental processes.........	13.47	14.11	13.58	14.17
Fundamental number comparisons	13.76	14.11	13.47	14.00
Arithmetic fundamentals.......	62.82	64.11	62.82	63.64
Average score for each test	18.59	19.24	18.68	19.28

The average score for each test, as shown in Table 19, provides the most meaningful basis for comparison of the average scores, since the average score for each test is virtually an average of the average scores and reflects the general trends throughout the various groups of tabulated data. For purposes of clarity and convenience, the average scores for each test will be referred to in this paragraph as "general average scores." These scores, like most of the average scores, tend to be higher for the activity class than for the conventional class. For the boys the general average score for the first submission of the seven tests is 1.45 points higher for the activity class than for the conventional class, but for the second submission it is .01 of a point lower for the activity group. Among the girls the general average score is higher for the activity class in both submissions, to the extent of .09 and .04 of a point for the first and second tests, respectively. The manner in which the girls surpassed the boys is adequately demonstrated by a comparison of the general average scores. In the conventional class they excelled the boys by 1.72 points and .35 of a point, respectively, for the first and second submissions of the test. In the activity class they surpassed the boys by .36 and .40 of a point, respectively, for the first and second testings.

These analyses indicate that, in both the conventional and activity classes, progress was made by both boys and girls in the second submission of each individual test, and that, on the whole, the girls experienced more marked progress than did the boys. It is also apparent that average scores for both boys and girls tended to be higher in the activity class than in the conventional class.

Comparison of Gains

Table 19 presented the average scores resulting from the testing of the pupils in the conventional and activity classes in seventh-grade arithmetic, and did not show clearly the actual gains on the second submission of the seven tests. Table 20 has been compiled for the purpose of showing at a glance the actual gains in points made in terms of average scores for both boys and girls in connection with the seven tests used by the writer in conducting her study. In addition to the average gains recorded by the boys and girls for each of the tests, the writer has computed the average of these averages in order to arrive at the average gain for each of the tests on the basis of boys and girls in the two classes.

An examination of Table 20 reveals the fact that the lowest average gain was .22 of a point, recorded for the boys in the conventional class, and that the highest average gain was 1.35 points, made by the girls of the conventional class. The second lowest and the second highest average gains were also made by members of this class. These gains were .35 of a point and 1.00 point, respectively, the first of which was recorded for the girls and the second for the boys. The writer is able to discover no explanation for the two high average gains of 1.35 and 1.00, although

TABLE 20

COMPARISON OF GAINS IN POINTS IN AVERAGE SCORES MADE ON THE SEVEN TESTS BY BOYS AND BY GIRLS IN THE CONVENTIONAL AND ACTIVITY CLASSES IN SEVENTH-GRADE ARITHMETIC

Tests	Gains by Pupils in the Conventional Class		Gains by Pupils in the Activity Class	
	Boys	Girls	Boys	Girls
Number comparison.........	.22	.35	.44	.58
Problem analysis..........	.66	.58	.66	.70
Finding keys to problems..	1.00	.70	.50	.41
Solving problems..........	.72	.82	.39	.64
Fundamental processes.....	.55	.64	.61	.58
Fundamental number comparisons................	.44	.41	.61	.64
Arithmetic fundamentals...	.83	1.35	.77	.88
Total average gain for all tests.....	4.42	4.85	3.98	4.43
Average gain for each test.........	.63	.69	.57	.63

the higher of the two may have been influenced by the fact that the girls of the conventional class had a somewhat higher average intelligence quotient than any of the other groups of boys and girls; this fact is clearly demonstrated in a comparison of Tables of 1 and 9. It is perhaps unwise, however, to say that intelligence had much to do with the two high gains; and possibly a more logical conclusion would be to ascribe these gains to coincident or chance, since any number of factors might have entered into their occurrence.

For four of the seven tests, the girls in the conventional class had higher average gains than did the boys in the same group; whereas in the activity class, the girls in five instances out of the seven had higher average gains than did the boys. Certain interesting comparisons are possible between the average gains of the pupils in the conventional class and those in the activity class. In the test on problem analysis the boys in both classes made identically the same average gain, but for the remaining six tests the average gains of the boys in the activity class were higher in three instances than those for the boys in the conventional class. The girls of the activity class fell slightly below the boys in comparison with the conventional class. For three of the seven tests the girls in the activity class had higher gains than those in the conventional class. A comparison of the averages of the average gains, reported in the table as "average gain for each test," reveals that in both classes the girls made a slightly higher average gain in each test than did the boys.

For both boys and girls the average gain for each test was slightly lower for members of the activity class than for those of the conventional class. Since, in Tables 17, 18, and 19, the pupils in the activity class are shown, on the whole, to have made greater progress than those in the conventional class, the writer is led to believe that the fact that, in Table 20, the two highest average average gains appear in the conventional class tends to upset the trend of scores that has been indicated in previous analyses and to cause the pupils in the activity class to appear at a slight disadvantage in connection with average gains made on the seven tests.

Summary

The data presented in this chapter may be concisely summarized in the following manner:

1. Average scores for pupils having the highest and lowest intelligence quotients in both classes indicated that intelligence exerts some influence upon the scores made by pupils in arithmetic tests.

2. In the group of pupils having the highest intelligence quotients, higher scores were equally divided between the conventional and activity classes; that is, five of the ten pupils in the activity class made average scores that were higher than those made by the corresponding five pupils in the conventional class, and the same was true of

five members of the conventional class in comparison with the corresponding five members of the activity class.

3. In the lowest-intelligence group, however, seven of the ten pupils in the activity class had higher average scores than those of the corresponding pupils in the conventional class.

4. No difference existed in the average of the average scores made by the highest-intelligence groups in both classes; that is, the figure for both was 20.1. With regard to the lowest-intelligence groups, however, a slight distinction was noted in favor of the activity class; that is, the average of the average scores for this class was .8 of a point higher than that for the conventional class.

5. In both classes, progress was made by both boys and girls when each of the seven tests was submitted for the second time four months after the first submission. On the whole, the girls made higher gains than did the boys. Average scores for both boys and girls tended to be higher in the activity class than in the conventional group.

6. An analysis of the actual average gains in points revealed that the gains for members of the activity class were slightly lower than those for the conventional class. Since this result is inconsistent with all other findings in the study relating to progress in average scores, it is ascribed to the fact that by far the two highest average gains occurred in the conventional class -- a situation

that unfortunately tended to upset the natural trend of the averages. If these two high scores are omitted from the reckoning, the average gains will support the previous findings, namely, that more progress was made by pupils in the activity class than by those in the conventional class in seventh-grade arithmetic.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The writer, after a careful examination of all the data that have been presented in the three preceding chapters of this thesis, believes that the study adequately substantiates the following conclusions relative to pupil progress under the formal and activity methods of teaching seventh-grade arithmetic:

1. Definite gains were made by both boys and girls in both classes when the seven arithmetic tests were submitted for the second time, four months after the first submission. Losses of points in the scores were so insignificant in comparison to the gains that they have been merely mentioned at the place of occurrence and have not been treated to an analysis.

2. In both classes the girls showed more progress than the boys in their scores for the tests in number comparison, the solution of problems, and arithmetic fundamentals. The boys in both classes made higher scores than the girls in the test on finding keys to problems. As to the three remaining tests, the boys surpassed the girls in problem

analysis in the conventional class, whereas the girls excelled in the activity class; in the test on fundamental processes, the conventional-class girls excelled and the activity-class boys surpassed; with relation to the test on fundamental number comparisons, the boys surpassed the girls in the conventional class, but the girls of the activity class showed slightly more progress than the boys.

3. In four of the seven tests given to the conventional class, the girls showed more progress than did the boys, whereas in the remaining three tests the boys exceeded the girls in points gained. In five of the seven tests submitted to the class that carried on the store project, the girls attained more progress than did the boys.

4. Average scores, when analyzed on the basis of pupils who had the highest and lowest intelligence quotients, indicated that in both classes intelligence had some influence upon the scores made by the pupils in the arithmetic tests used in this study. That is, the pupils with the highest intelligence quotients tended to make higher test scores than did those among the lowest-intelligence group.

5. A comparison of the average scores for the pupils in the highest-intelligence groups of both classes revealed that both groups attained approximately the same rate of progress. In the lowest-intelligence groups, however, the pupils in the activity class made somewhat higher average scores than did those in the conventional class.

6. On the whole, girls in both classes made higher gains than did the boys. Average scores for both boys and girls tended to be higher in the activity class than in the conventional class.

7. On the whole, then, it is safe to conclude that the activity method of teaching seventh-grade arithmetic is slightly more conducive to pupil progress in the seven phases of arithmetical skill and knowledge encompassed in the tests utilized by the writer in conducting her study, than is the formal or conventional teaching procedure.

Recommendations

On the basis of her study, as reported in these pages, the writer believes that the following recommendations are worthy of consideration:

1. Teachers of arithmetic should strive to overcome their misgivings as to the adequacy of an activity program of teaching in equipping the pupil with those skills and abilities in mathematics that are usually acquired in conventional classes by means of routinized procedures. So far as the present investigation can be accepted as an accurate index to the problem, it appears that arithmetical skills and abilities are acquired slightly more readily in an activity program of teaching than in a formal one.

2. Teachers of arithmetic should make a greater effort to organize their class procedures around the idea of

meaningful arithmetical activities, for these are not only more conducive to learning, but probably contribute more pleasure and enthusiasm to the learning processes than is true of the formalized program. The activity in arithmetic does more than simply teach the subject matter; it is also conducive to the well-rounded development of the pupil in social and economic relationships.

3. A larger number of studies similar to this one should be conducted in order to establish, by volume of investigation and thorough study, those educational values that are inherent in certain learning situations. Other studies, conducted along different lines and among different people, may either support or refute the findings of the present writer, but in either case they will add something to the total understanding of those teaching and learning situations that are most conducive to progress in arithmetic.

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