THE UNIVERSITY OF MANITOBA

A REPORT ON AN EXPERIMENT TO EVALUATE THE EFFECTIVENESS OF TWO DIFFERENT METHODS OF TEACHING ARITHMETIC AT THE GRADE ONE LEVEL

BEING A THESIS SUBMITTED TO THE COMMITTEE ON POST GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

by

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Winnipeg, Manitoba
April 1961

ACKNOWLEDGMENTS

Grateful acknowledgment is made by the writer to the following persons who have helped make possible the experiment reported in this thesis: Mr. A.D. Thomson, Assistant Superintendent of Winnipeg schools for his co-operation and assistance; the principals and vice-principals of the twenty-eight schools involved in the experiment for their permission to conduct a testing programme in their schools; the twenty-two teachers of the experimental and control classrooms for their interest and enthusiasm, and for their integrity in adhering to the experimental conditions; to the primary supervisors for their assistance in administering the Power Test; and to the 794 Grade One children who were subjected to the testing programme.

Special acknowledgment is extended to Miss Doris Baker for her invaluable guidance, encouragement, and constructive criticism, without which the compilation of this report would not have been possible.

ABSTRACT

During the school year 1959 - 1960, a controlled experiment involving 794 children was conducted in the Winnipeg schools in order to evaluate the relative effectiveness of two different methods of teaching arithmetic at the Grade One level, namely the Cuisenaire method and that suggested in the Living Arithmetic Series.

The philosophical and psychological bases underlying the two methods were compared and contrasted. All available research in the field of arithmetic applicable at the Grade One level was summarized. The Grade One programmes of eight arithmetic series other than those under comparison in the experiment were summarized and compared. All available research into the Cuisenaire method was recorded.

Eleven experimental classes consisting of 309 children were matched with eleven control classes of 285 children. Every precaution was taken to ensure that the experimental and control classes were comparable in regard to intellectual ability, that the schools were comparable in respect to size and socio-economic area, and that the teachers were matched as far as possible in respect to experience, ability, and interest and success in teaching arithmetic.

In the course of the testing programme tests were

administered as follows: readiness test at the beginning of the experiment, an achievement test in March and again in June, and an intelligence test in May.

To test achievement, a Power Test was prepared and validated by the writer. The test consisted of three parts: Part One testing competence in the work covered in the Grade One arithmetic course authorized by the Minister of Education for the Province of Manitoba; Part Two testing ability to apply computational skill and mathematical understandings in novel or unfamiliar situations; Part Three testing concepts peculiar to the Cuisenaire course.

In order to validate the Power Test, a preliminary test was constructed and given to one hundred children in three Grade One classes ranging from slow to accelerated in three schools in various socio-economic areas of Winnipeg. An Item Analysis was done and the test was revised. A second preliminary test was given to another one hundred children in three more classes ranging from slow to accelerated in three more schools in various socio-economic areas of the city. A second item analysis was done and a second revision made before the Power Test was finally constructed.

To obtain the subjective assessment of all persons involved in the experiment, questionnaires concerning the advantages and disadvantages of the Cuisenaire method and materials were sent to all teachers and administrators of the classes concerned.

The normality of the sample taking part in the experiment was tested by the "Goodness of Fit" techniques. By means of ungrouped data, the writer computed, described and compared the mean, the standard deviation and where applicable a frequency distribution and a histogram for each of the groups for each section of the testing programme. The gains made by each group during the period March to June were also computed and compared.

The replies to the questionnaires were recorded and summarized.

The following generalizations regarding the relative effectiveness of the two methods of teaching arithmetic were drawn from the objective and subjective results:

1. The Cuisenaire method is a generally better method of teaching arithmetic to children at the Grade One level than that being employed at present in the Winnipeg schools.

2. All persons concerned with the experimental classes agreed that the children in these classes achieved better results and enjoyed arithmetic more than those they observed being taught by the traditional method. They were unanimous in their opinion that the Cuisenaire materials be used on a larger scale in the future.

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INTRODUCTION

PURPOSE OF THE THESIS

During the school term September 1959 to June 1960, under the direction of Mr. A.D. Thomson, Assistant Superintendent of Schools, Winnipeg School Division No.I, the writer conducted a study in the Winnipeg School Division. The study was undertaken in order to secure some factual evidence regarding the relative achievement in arithmetic at the Grade One level, of pupils taught by the Cuisenaire method and of those taught by the traditional method employed at that time in the Winnipeg schools.

The purpose of this thesis is to report the procedures, and to evaluate the results of this controlled experiment in the light of the research done in arithmetic at the Grade One level during the past few years.

HOW THE STUDY CAME ABOUT

In order to meet the requirements and to attain the aims and objectives of arithmetic as outlined by the Minister of Education for the Province of Manitoba, Jolly Numbers, Primer[1] and Jolly Numbers, Book One[2], the Grade One books of the Living Arithmetic Series, had been used in Grade One in the Winnipeg Schools since February 1954. While the results obtained through using the Living Arithmetic Series were considered to be satisfactory, such outstanding results were claimed by school systems in other parts of the world using the Cuisenaire materials, that Dr. W.C. Lorimer, Superintendent of Schools for the Winnipeg School Division, No.1, decided that the Cuisenaire method should be used exclusively on an experimental basis in several Grade One classrooms in Winnipeg for one school year commencing September 1959.

When the present programme in arithmetic was authorized by the Minister of Education for the Province of Manitoba in 1953, no text was designated for use at the Grade One level. The aims and objectives and the topical outline to be followed in all public schools in Manitoba were set out and made available to all teachers in the programme of studies Arithmetic Grades I - VI[3], but the decision as to which text to use, if one were considered necessary, was left to each individual school board.

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1. Guy T. Buswell et al., Jolly Numbers, Primer, Revised Edition, (Toronto: Ginn and Company).

2. Guy T. Buswell, William A. Brownell and Lenore John, Jolly Numbers, Book One, Revised Edition, (Toronto: Ginn and Company).

3. Arithmetic Grades I - VI, Authorized by The Minister of Education, Province of Manitoba, (Winnipeg: R.S. Evans, Queen's Printer for the Province of Manitoba, 1953).

Because it was found that the Grade One books of the Living Arithmetic Series paralleled so closely the outline authorized by the Minister of Education, Mr. A.D. Thomson sent out a directive on February 23, 1954, to all Grade One teachers in Winnipeg, advising them that they were to be provided with the Grade One books of the Living Arithmetic Series to assist them in their teaching of arithmetic. In accordance with this directive, the Living Arithmetic Series had been in continual use in all Grade One classrooms in Winnipeg from February 1954 until the introduction of the Cuisenaire materials in eleven classrooms in September, 1959

THE LIVING ARITHMETIC SERIES METHOD AND THE CUISENAIRE METHOD OF TEACHING ARITHMETIC

A study of the Living Arithmetic Series and of the Cuisenaire method indicates that the authors of these two systems hold quite different views in regard to the aims and objectives of arithmetic and the outcomes expected at the end of Grade One. It also indicates that the philosophy and psychology underlying the two systems are vastly different.

THE LIVING ARITHMETIC SERIES

The authors of The Living Arithmetic Series of which Jolly Numbers is a part, Guy T. Buswell, William A. Brownell and Lenore John, maintain that although arithmetic is in the elementary curriculum because of its social value, it has been failing to make its expected social contribution. They state that it has become a narrow 'school subject', functioning neither in the life of the child learner, nor in the later life of the adult. The authors want children and adults to be efficient in solving the quantitative problems they cannot escape, but they want more than this. They want children and adults to be intelligent in quantitative situations. They want them to become increasingly sensitive to new number needs and to see new uses for the arithmetic they know. They assert that quantitative intelligence, not quantitative efficiency, should be the goal.

They claim that expertness in quantitative thinking can be developed only by making number and number processes meaningful. The authors believe that the more meaningful arithmetic is made, the more significant it becomes; the more significant it becomes, the more attractive its meaning should be.

According to Buswell, Brownell and John, both mathematical and social purposes are essential to a complete arithmetic programme, but in the last analysis the reason for teaching arithmetic is not mathematical but social. It is the authors' contention that arithmetic is taught in order that children may adjust more happily and more intelligently to a culture which steadily becomes more quantitative.[4]

The goal of the authors of the Living Arithmetic Series has been "to make arithmetic appear to children attractive, challenging, sensible, useful and 'natural'; to help them enjoyably and understandingly to develop a kind of thinking which will make them live more happily and more intelligently".[5]

The authors of the Living Arithmetic Series suggest the following nine principles of method:

1. Orderly development in quantitative thinking must be insured.
2. Children must be helped to see sense in what they learn.
3. Childrens' activities must harmonize with the purpose of arithmetic.
4. Symbols must be withheld until meanings are developed; drill must be withheld until understandings are developed.
5. The way children think of numbers should be of as much concern to the educator as the result of their thinking.
6. Teachers must teach at the rate at which children learn.
7. Arithmetic must be presented as an object of 'natural' interest.

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4. Guy T. Buswell, W.A. Brownell and Lenore John, <u>Teachers' Manual for Living Arithmetic Grade Three</u> Revised Edition, (Toronto: Ginn and Company, 1947), pp. 1-9.

5. <u>Ibid</u>. p.1.

8. Instruction must be organized 'spirally'.

9. Children must know both what they are to learn and how well they are learning it.[6]

Buswell, Brownell and John claim that the foundations upon which their textbooks are built are sound. In their hope to evolve a theory of learning and a programme of instruction that would be integrated and consistant, they claim to have made extensive use of research. They state that they have read all published investigations and have digested what they have read. When their study of research has left them unconvinced of the merits claimed for this or that practice or scheme of organization, they admit quite frankly that they have followed custom. They regret that so many important aspects of arithmetic have not yet been thoroughly investigated.[7]

THE METHOD

According to the authors, the Living Arithmetic Series

> ....encourages the child to learn through reflective thinking; it emphasizes the need and value of each new item before learning; it provides many different types of experience;it enables the child to proceed slowly enough to understand what he is learning; it demands activity at every point, and activity of a known kind. In a word, it helps the child to see arithmetic both as a system of quantitative thinking and as a means of intelligent social participation.[8]

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6. Ibid. pp. 5-9.
7. Ibid. pp. 10 - 11.
8. Guy T. Buswell, W.A. Brownell, and Lenore John, Teachers' Manual to Accompany Jolly Numbers, Primer and Book One, Revised Edition, (Boston: Ginn and Company, 1956), p. 66.

OUTCOMES EXPECTED AT THE END OF GRADE ONE

The outcomes expected at the conclusion of _Jolly Numbers, Book One_ are:

1. Enumeration to 100 by 1's and ordinals to eighth.
2. Counting to 100 by 1's and 10's.
3. Reading and writing numbers to 100.
4. Knowledge of the place of the numbers in the series to 100.
5. Understanding of the significance of 10 as the basic unit in the second decade numbers (and some appreciation of its significance in larger numbers).
6. Intelligent control over the separate addition and subtraction combinations through 9.
7. Understanding of addition as the process of putting numbers together, and of subtraction as the process of taking away a part (two ideas, "How many left" and How many gone").
8. Understanding of the relationships between addition and subtraction, and between the addition combinations and their corresponding subtraction combinations (Direct and Reverse).
9. Column addition to sums of 9, three addends with and without zero.
10. Understanding of ½ as applied to single objects.

11. Simple reading vocabulary for arithmetic.

12. Appreciation of the social values of arithmetic, a disposition to use the arithmetic already learned, and an eagerness to learn more.[9]

In their conclusion, the authors assert that the course represented in Jolly Numbers, Primer, and Jolly Numbers, Book One, is the result of a long period of tryout, is well within the grasp of the average six year old child and requires of him very little reading.

THE CUISENAIRE METHOD OF TEACHING ARITHMETIC

The Cuisenaire method is named for its inventor, Georges Cuisenaire, Director of Education in the town of Thuin in the Belgian province of Hainault. Dr. Caleb Gattegno, a former professor of mathematics at London University, and secretary of the International Commission for the Study and Improvement of the Teaching of Mathematics, is responsible for the development and publication of the method. "The essential idea of the method is that by using colour functionally, the gap between the concreteness of everyday life and the abstractness of arithmetic can be easily bridged".[10]

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9. Ibid. pp. 68 - 75.

10. C. Gattegno, "Arithmetic with Colored Rods, The Cuisenaire Method," Times Educational Supplement, 2064:1081 (November 19, 1955), p.1.

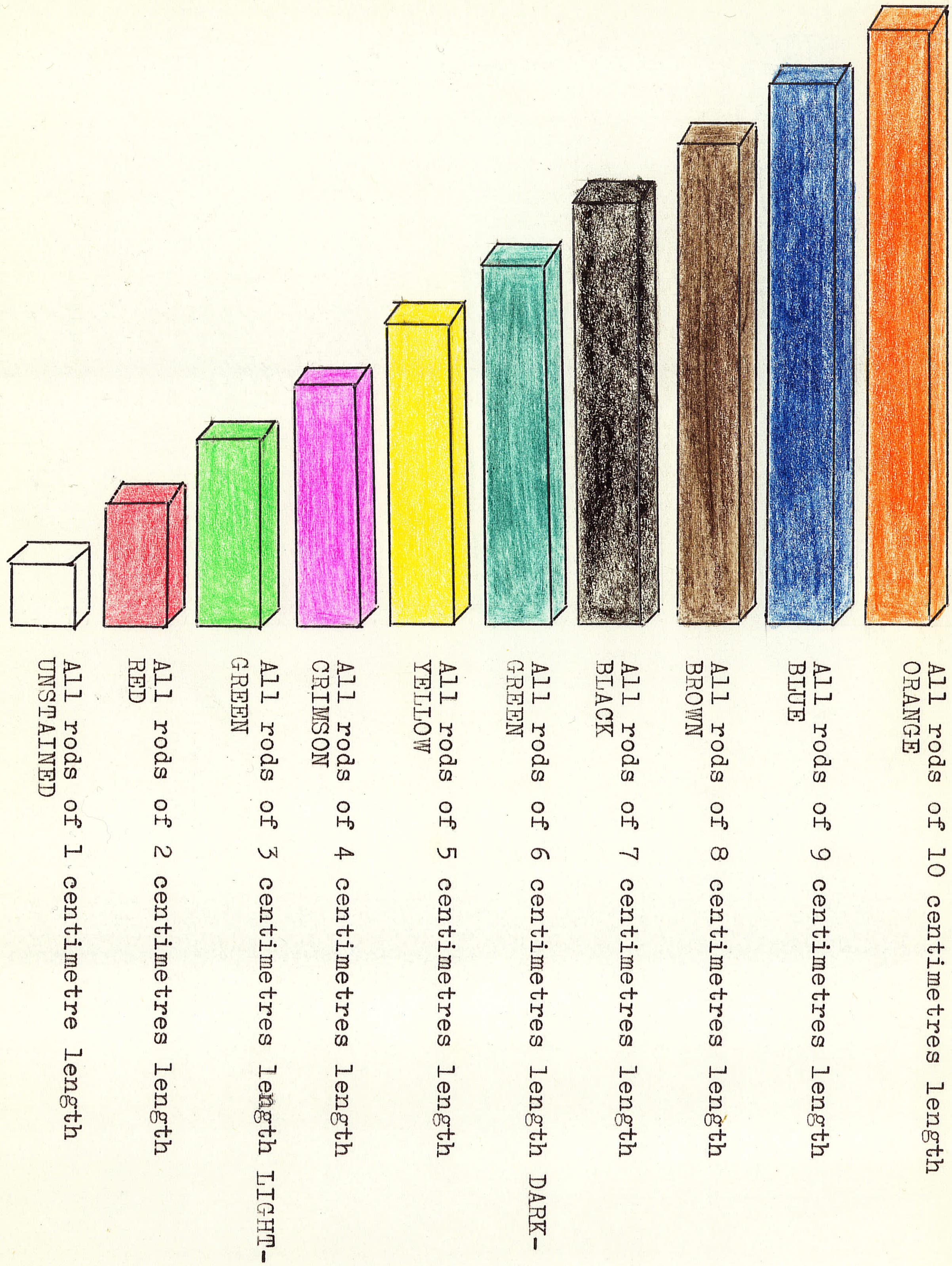
MATERIALS USED

Cuisenaire has created an educational material with sets of wooden rods, 241 to a box, with cross-section one square centimetre, coloured according to the following schema.

Cuisenaire claims that colour plays an important part in the method. In the first place he considers that it adds to the attractiveness of the materials. Secondly, he believes that it reflects a relationship between the rods. Cuisenaire has not chosen the colours at random; the rods are deliberately grouped in families, and the colours at once convey size and various relationships. The pigments are such that the rods of 2, 4, 8 centimetres are warm colours in shades of red; those of 5 and 10 centimetres have a yellow base; those of 3, 6, 9 centimetres are cool colours in shades of blue, while the 1 centimetre cube is unstained and the 7 centimetre rod is black. The order and ratio of the numbers are the same as the ratio of the light frequency of the colours.

> The colours also provide a means of reference and identification. This means that before a child has any specific number knowledge, he can study certain mathematical ideas in terms of "generalized number". For example take a+b = b+a. This can be seen in terms of colour as "red plus light-green equals light-green plus red". Again (a+b)+c = a+(b+c), or, in terms of colour, (red plus light-green) plus crimson equals red plus (light-green plus crimson). A further example is - yellow plus crimson equals red plus black.

SCHEMA OF CUISENAIRE RODS



It must be appreciated that mathematical laws such as these must be understood before a child can appreciate that 2+3=3+2=5 or that 5+3=7+1=8. Unhindered by inadequate number knowledge, the child can, from the very beginning, build a thorough understanding of mathematics by simply talking about things he can see and knows to be true.

The material is semi-abstract, that is to say, it can be used to symbolize many things. In play it can be made into houses, bridges or trains; it can represent people, cars and a myriad of other objects. In number the orange rod can be ten, five, two, or one, depending on which rod is used as a unit. Unlike the pictures or drawings so often used in the infant-room to-day, the rods have no meaning of their own; it is only when they are related to another rod specifically nominated as the unit that they take on a value.[11]

Teachers first seeing the rods will immediately recognize that if the unstained rod is one, we have in the box a symbol for all the numbers from one to ten. Often this has misled teachers into telling the children that the red rod is two, the light-green rod is three, etc. However, this is not necessarily true; there is no reason at all why the red rod can't be one -which would consequently make the orange rod five; - or why the light-green can't be one, or the crimson or even the orange. There are no characteristics of the rods themselves, such as marks or graticules, to prevent this. Unless this idea is appreciated, the value to be obtained from the Cuisenaire material will be greatly reduced.[12]

THE METHOD

The following is a condensation of the theoretical basis underlying the Cuisenaire method of teaching arithmetic

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11. The Educational Magazine, March, 1959, reprinted in New Ideas on Arithmetic, Department of Curriculum and Research, Melbourne, Australia, pp. 2-3.

12. "New Ideas on Arithmetic - The Cuisenaire Material" (Department of Curriculum and Research, Education Department, Melbourne, Australia), p. 14 (Mimeographed).

as outlined in the booklet, Numbers in Colour[13].

Cuisenaire and Gattegno claim that in using Cuisenaire rods, number concepts grow through seeing, associated with doing, understanding, reckoning and checking.

Seeing

Numbers and their multiples are represented by related colours.

The various lengths being of regular gradation allows of active use of eyes and hands.

Dimensions and colours constitute a double link between numbers.

Doing

The child's need for action finds an outlet in the spontaneous construction of numerous combinations, freely produced by him and based only upon his awareness of relationships and groupings of numbers.

Understanding

Seeing and doing lead to conviction and to ease in retaining results. The imagination is stimulated and reckoning becomes automatic.

Reckoning

Through manipulating the rods the child discovers

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13. G. Cuisenaire and C. Gattegno, Numbers in Colour, (London: William Heinemann Ltd., 1958).

new combinations which increase not only his skill in calculating, but also his interest, experience and knowledge.

Verification

This is an important phase of the child's experimental work, for he checks his own results and learns to rely on his own criteria for correcting his mistakes.[14]

It is the authors' contention that as mathematical facts are acquired through the impression of colour, length and touch, quantities are established in the children's minds and that because the method is one of discovery and because the children are taught from the beginning to work with relationships rather than with specific numbers, what the children know they will know for good.

OBJECTIVES OF THE CUISENAIRE METHOD

The aims or desired outcomes of elementary school mathematics outlined in the Forty-fifth Yearbook of the National Society for the Study of Education, The Measurement of Understanding are:

1. Computational skill

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14. *Ibid*. pp. 20 - 21.

2. Mathematical understandings

3. Sensitiveness to number in social situations and the habit of using number effectively in such situations.[15]

Cuisenaire and Gattegno while stressing the first two of these aims, place very little emphasis on the third one. They maintain that:

> The main objective in the teaching of arithmetic in the primary school is to make the child capable of accurate and rapid reckoning....50% of our pupils seem unable to achieve this by the methods ordinarily used ... In our view it is the methods used to make reckoning an unconscious process that are at fault. It is only when calculation becomes automatic that the mind is free to enter other fields, in particular to reason. The habits that lead to this automatism are acquired through constant repetition of concrete numerical combinations which the child himself can check on the spot. Hence what has to be discovered is the means by which the child can pass easily and with certainty from the stage of observation (seeing, touching, feeling) to that of firm consolidation at the concrete level, as a preliminary to abstraction and subconscious automatism.[16]

Gattegno says:

> In our opinion mathematics has never been taught in school. What has been taught is bits and pieces of knowledge, and it is matter for marvel that in spite of this fact some people have become mathematicians. It is not to be wondered at that the

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15. The Measurement of Understanding, Forty-fifth Yearbook of the National Society for the Study of Education, Part I, (Chicago: University of Chicago Press, 1946), pp.138.

16. Cuisenaire and Gattegno, op. cit., p. 19.

majority of our clever pupils understand nothing of the subject and quickly drop it. If they are to be won over to mathematics, all that is needed is that we expose them to true mathematics. Since mathematical activity is natural, there is no more reason to fail in it than in walking or talking, when the necessary mechanisms are present.

Our approach to the teaching of mathematics, then will be the following: we shall teach algebra before arithmetic (the latter no longer being a collection of recipes for the solution of impractical problems, but the study of the properties of numbers); giving our pupils the full benefit of the thinking of the mathematicians of the last eighty years, and exposing them to structured fields of study. Thus the emphasis on Euclidean geometry will disappear, and the false sense of rigor which was considered to justify that study will be replaced by a progressive widening of the fields, a deeper understanding of the assumptions and clearer statements of the results obtained. With all this expressed in adequate notations, what the pupils produce looks singularly similar to what mathematicians publish. We shall have satisfied criteria which are at the same time psychological, pedagogical and mathematical - and this is something new .... When algebra precedes arithmetic, freedom comes into its own and the effective straightjacket of discipline is forgotten. Elementary mathematics learning then serves the true education of the child. Because we use actual gestures upon actual objects and ask the appropriate question, we give every child every chance to see, instead of leaving him to guess, what we mean.[17]

OUTCOMES EXPECTED AT THE END OF GRADE ONE

According to the Cuisenaire method, children at the

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17. C. Gattegno, The Cuisenaire Discovery, (New York: Foundation for Integrated Education Inc., Jan., 1958), pp. 52 - 53, Reprinted from Main Currents in Modern Thought.

end of Grade One should have an understanding of all the factors and of all the relationships of the numbers one to ten, and of all relationships between these numbers. This includes all the addition, subtraction, multiplication and division facts of these numbers, plus all the fractional parts of the numbers.

The authors summarize the learnings of the first year's work as:

> 1. Identification and precise and systematic knowledge of the first ten numbers. The operations studied will include 1/2; 1/3; 1/4; 1/5; 2/3; 2/4; 3/4; 2/5; 3/5; 4/5.
>
> 2. Location of the numbers between 10 and 20, either by doubling: 2, 4, 8, 16; 5, 10, 20; 9, 18; 7, 14; or by counting 11, 13, 15, 17, 19. (location of numbers does not mean that there is identification).
>
> 3. Identification of the numbers located between 10 and 20. This takes place as before, and the operations 1/6, 1/8, 2/6, 3/6, 4/6, 5/6, 2/8, 3/8, 4/8, 5/8, 6/8, 7/8 are added to the previous fractions.[18]

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18. Cuisenaire and Gattegno, op. cit., p. 26.

DIFFERENCES IN THE TWO METHODS IN REGARD TO COUNTING

The authors of the Living Arithmetic Series and of the Cuisenaire method hold opposing views in respect to counting.

The Grade One course of the Living Arithmetic Series leans heavily on counting. From beginning to end of the Jolly Numbers, Primer, and Jolly Numbers, Book One workbooks, many exercises are found involving counting. The addition and subtraction facts of each number from one to nine are introduced by counting. For example, when the child is ready to learn the facts of nine,he is shown four pictures of bowls of nine tulips and told to do such things as:

1. Colour 6 tulips yellow and 3 red.
   How many in all?
   Take away the red tulips.
   How many left?

2. Colour 4 tulips purple and 5 red.
   How many in all?
   Take away the purple tulips.
   How many left?

3. Colour 2 tulips black and 7 pink.
   How many in all?
   Take away the black tulips.
   How many left?

4. Colour 8 tulips red and 1 purple.
   How many in all?
   Take away 1 purple tulip.
   How many left?

The authors of this series consider that Grade One children should spend much time counting first concrete objects and then pictorial representations of concrete objects.

They maintain that when a child counts objects he is adding 'ones'; when he puts two groups of objects together and counts them he can tell how many there are in all; when he takes one group of objects away and counts the number of objects remaining he finds the number left. While the ultimate goal is to know the addition and subtraction combinations for the first nine numbers without counting and without using objects, yet counting is considered by Buswell, Brownell and John, to be acceptable behaviour when the Grade One child is introduced to each new number fact.

Brownell has identified four levels of development from immature to mature in responding to number facts:

> (1) counting, (2) partial counting, (3) grouping, and (4) meaningful habituation. Whether a child should be allowed to find answers by counting depends on his level of development. In the early stages of learning the facts, he should be allowed to find answers by counting, and grouping. As he matures he should approach and attain the level of meaningful habituation..........................
>
> The teacher can feel confident that counting is acceptable behaviour for the child in the early stages of learning; he must also accept the fact that his guidance includes helping the child grow from less mature to more mature behaviour.[19]

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19. William A. Brownell, "The Development of Children's Number Ideas in Primary Grades," Supplementary Educational Monographs, No. 35, (Chicago: University of Chicago Press, August 1928), quoted in Vincent J. Glennon and C.W. Hunnicutt, What Does Research Say About Arithmetic? A Report for the Association for Supervision and Curriculum Development, (Washington: 1957). p.19.

Gattegno disagrees with the idea that children should depend on counting, even in the early stages of development. He has said that:

> ....learning mathematics is a most natural activity comparable to fundamental biological activities such as walking, talking, driving, etc. It is concerned not with knowledge related to memory, but to knowing how, and to biological organization linked with reflexes. By making mathematics dependent on memory as we do through counting, tables, rules, we denaturalize mathematics and force the child to meet reality clad in a garment that does not belong to reality and does not fit it .... To say that mathematics is concerned with intellectual rigor, is to forget that we feel mathematics as well as think it,........ Our traditional arithmetic is in all its aspects paralyzing, uninspired, and therefore, pedagogically wrong.[20]

In summary, the two methods of teaching arithmetic being evaluated in this study, differ greatly in respect to objectives, materials used, methods of teaching, and outcomes expected at the end of Grade One.

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20. C. Gattegno, "Thinking Afresh About Arithmetic", The Arithmetic Teacher, Vol. VI, No.1, (February, 1959), pp. 30 - 32.

CHAPTER II

RECENT RESEARCH IN ARITHMETIC AT THE GRADE ONE LEVEL

INTRODUCTION

> Next to reading there are more research studies on arithmetic --- its techniques, methodology and theory of learning --- than on all other content subjects in the curriculum, and the findings from these studies are gradually making their way into classroom instructional practices. Although critics of the school program make many invidious comparisons between the arithmetic competency of modern students and those of the past, research has established the fact that school children today are significantly better in this subject than those of 25, 50, or 100 years ago. There are schools in which arithmetic really functions in the lives of the children; there are many children who enjoy arithmetic. But at the same time, there is much understanding and knowledge which research has developed about the teaching of arithmetic that is not yet a part of the instructional programmes of most of the schools in this country.[1]

Since the improvement of learning in arithmetic depends to a considerable extent upon the degree to which the teacher understands and implements in his teaching the findings of research studies, it is important that the educator knows what research has been done in the field of arithmetic pertaining to the grade level with which he is concerned.

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1. "Research in Arithmetic", Canadian Research Digest, Vol. I, No.2, (Spring, 1959), p. 52.

After analyzing the research reported in recent years in the field of arithmetic, which if put into practice would be of value to the Grade One teacher, the writer arrived at the following conclusions:

1. The great bulk of research reported at this level is based on the informed judgment of authorities in the field of arithmetic rather than upon controlled studies.
2. These findings are primarily of a theoretical rather than of a scientific nature.
3. Many of the generalizations made are based on the psychological principles of learning.

Research which should be of interest to the Grade One teacher has been reported on the following topics:

A PLANNED CURRICULUM

To those teachers who believe that "modern education requires a planless curriculum, with learning experiences eventuating from fortuitous interest",[2] and to those at the other extreme who believe that "the curriculum should be laid out in great detail with little or no provision for the needs and interests of the learner," research has

2. Vincent J. Glennon and C.W. Hunnicutt, What Does Research Say About Arithmetic? A Report for the Association for Supervision and Curriculum Development, (Washington: 1957). p.5.

said that neither of these two extremes is supported in theory or in practice.[3]

> On the basis of evidence now available, the incidental experience approach has not produced a superior substitute for the more systematic and mathematical organization of content, but it may well provide some highly interesting supplements to the systematic program.[4]

Caswell and Foshay have said:

> ....the "planless" curriculum, as commonly described by those who oppose it, is accepted by nobody. It is impossible to find proposals that planning should be dispensed with entirely and the inclination of the moment followed in the situation as it unfolds. It is equally impossible to find proposals which support the "drillmaster", "expert-dominated" curriculum developed without regard to the interests and concerns of children. These extremes simply do not exist either in theory actually supported, or in practice which is accorded approval by competent students.[5]

According to Brueckner and Grossnickle:

> .... arithmetic instruction in the primary grade should proceed on a systematic, planned basis. From the beginning, the children should participate under teacher guidance in well selected activities which will show them how arithmetic functions in their daily lives.[6]

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3. Ibid. p.5.

4. "Arithmetic", Encyclopedia of Educational Research, Third Edition, (New York: Macmillan Company, 1960), p.65.

5. Hollis L. Caswell and Wellesley A. Foshay, Education in the Elementary School, Second Edition, (New York: American Book Company, 1950), quoted in Glennon and Hunnicutt, op. cit., p.6.

6. Leo J. Brueckner and Foster E. Grossnickle, How to Make Arithmetic Meaningful, (Philadelphia: The John C. Winston Company, 1953), p. 60.

Morton's contention has been that sequential step by step teaching is essential. He has said:

> Today's arithmetic program recognizes that the so called fundamental skills - addition, subtraction, multiplication and division - are not single, simple skills but that each is a complex of many elements. To achieve success, pupils must be led through a series of carefully planned and graded steps. In the majority of pupils in any class or any school system, it is essential that every new step be given specific attention and that none be omitted. Even for the fastest learners, this step by step development is the most economical teaching procedure and offers the most secure foundation for future more specialized work in high school and college.[7]

THE MEANING THEORY AND THE DRILL THEORY

There are two distinct theories practiced today in the teaching of arithmetic. The first may be designated the meaning theory; the second, the drill theory.

> According to the meaning theory, learning results from a variety of different meaningful experiences instead of from a series of repetitions of one pattern of thought . The meaning theory recognizes that there are differences in levels of performance for any given operation. The lowest level of performance for finding the sums of 3 and 4 may consist of counting concrete objects, such as 3 and 4 toys. The adult level of operation consists of giving an automatic response of 7 to the stimulus, 3 + 4. There is a great gulf between the first level of operation and the final adult pattern of thought in this case. According to the drill theory, the pupil bridges this chasm by repetition at the adult level of performance. According to the meaning theory, the pupil progresses on a

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7. Robert L. Morton, "Arithmetic and the Changing Times", The Resourceful Teacher, Number 2, (Morristown, New Jersey: Silver Burdett Company), p.2.

series of planned activities which are meaningful to him. Each new activity is performed at successively higher levels of operation until he arrives at the stage at which he is able to give a response of 7, with assurance, to the stimulus, 3+4. The drill method demands instantaneous and automatic responses. The meaningful approach places understanding before speed of response.[8]

According to the drill theory, learning results from repetition, ... It depends upon repetition of the facts until the response becomes automatic. The stimulus 3+4 is supposed to call forth the response 7, instantaneously...... Each fact is learned in isolation. There is no conscious attempt on the part of the teacher to have the pupils see or discover relationships among basic facts. Therefore in an instructional program of this kind, pupils seldom realize the orderly and sequential character of our number system.[9]

THE MEANING THEORY - HOW IT AFFECTS HOW WE TEACH

Buswell has said that:

The application of memorized rules that are not understood, which characterized the teaching of arithmetic fifty years ago has been replaced by an emphasis on understanding.[10]

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8. Foster E. Grossnickle, William Metzner, and Francis A. Wade, Number as the Child Sees It, (Philadelphia: Booklet distributed by the John C. Winston Company), p.2.

9. Grossnickle, Metzner, and Wade, loc.cit.

10. G.T. Buswell, "Introduction," The Teaching of Arithmetic Fiftieth Yearbook of the National Society for the Study of Education, Part II, (Chicago: University of Chicago Press, 1951), p.2.

Computational efficiency which was almost the sole criterion of arithmetical ability forty years ago is no longer considered sufficient. The teaching of arithmetic has been steadily moving toward the development of an understanding of number relations and of the number system.[11]

In recent years there has been an increasing interest:

> ...in the social as contrasted with the strictly mathematical objectives of the subject. This has appeared as a movement to make arithmetic meaningful to the learner. The research basis for the idea originally derived from the numerous studies in the psychology of learning, which have shown the advantage of learning with understanding as contrasted to learning by drill without an attempt to understand.[12]

Brownell has explained why it is important to develop meanings in arithmetic and has shown that meaningful learning is psychologically sound. He has suggested the following principles.

> 1. Arithmetic can function in intelligent living only when it is understood .... In practical living we must be intelligent in quantitative situations. For many years we have been told that skills can be used intelligently only when they have been acquired intelligently; hence, the importance of meanings in arithmetic.
>
> 2. Meanings facilitate learning,...... Through meanings we secure insights and note relationships....which enable us to foresee connections

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11. G.T. Buswell, "The Psychology of Learning in Relation to the Teaching of Arithmetic", <u>The Teaching of Arithmetic,</u> Fiftieth Yearbook of the National Society for the Study of Education, Part II, (Chicago: University of Chicago Press, 1951), p.154.

12. "Arithmetic", <u>Encyclopedia of Educational Research,</u> Third Edition, (New York: Macmillan Company, 1960), p.64.

and to tie together various aspects of the learning task which, without understanding, would have to be mastered separately, one at a time.

3. Meanings increase the chances of transfer.... It is because meanings do transfer that they facilitate learning. Whatever extra time may be required at the outset to teach meanings is more than regained later on through quicker and more intelligent learning. The effects of meanings are cumulative: their contributions to learning increase in amount as they enable the learner to gain new insights, to discover short cuts, and to apply in new ways what he has learned.

4. Meaningful arithmetic is better retained and is more easily rehabilitated than is mechanically learned arithmetic.....Meanings strengthen skills by supplying a structure to support them. When the skills themselves no longer function, the structure remains, and on this basis the skills can be renewed.[13]

THE PLACE OF PRACTICE OR DRILL IN ARITHMETIC

There is no research available to the writer which indicates that practice in arithmetic can be eliminated.

Morton has said that there is sound psychological theory which indicates that we must have practice.[14]

> Research has indicated that drill still has a place in the methodology of arithmetic, but its relation to the total learning process is much better understood than was the case during the twenties. The importance of meaningful instruction during the learning process has been widely accepted

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13. William A. Brownell, "When is Arithmetic Meaningful?" Journal of Educational Research, XXXVIII (March 1945), pp. 494-497. Summarized in Glennon and Hunnicutt, <u>op. cit.</u>, pp. 14-15.

14. Robert L. Morton, "Teaching Arithmetic", <u>What Research Says to the Teacher</u>, (2), Department of Classroom Teachers, American Educational Research Association of the National Education Association, (October, 1953), p.20.

> but drill has been shown to have definite value in maintaining skills already learned and in increasing speed in computation.[15]

It has been found generally that less practice is required if the practice follows meaningful experience than if the meaningful experience phase is omitted.

Morton has said that while it has been recognized that drill in arithmetic is not only valuable but essential, it is a well known fact that learning depends upon insight and understanding, and if children are expected to memorize number facts and processes meaningless to them, they will find themselves "in a wilderness of unknown symbols and meaningless names."[16]

He maintains that:

> ....the major trouble with the drill or practice which was provided in the old-fashioned school was that it came before meaning was developed. We know now, beyond reasonable doubt, that if we provide drill too early, it will lose much of its effectiveness. Drill should follow, not precede the development of meaning.[17]

Morton considers that:

> ....the drill theory of teaching arithmetic is gradually giving way to .... the meaning theory. Although drill is still necessary.... the processes of arithmetic must be meaningful else drill will be ineffective.[18]

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15. "Arithmetic", Encyclopedia of Educational Research, Third Edition, (New York: Macmillan Company, 1960), p.68.

16. Robert L. Morton, The Teaching of Arithmetic in the Elementary Grades, (New York: Silver Burdett Co., 1938), Vol. II, p.5.

17. Robert L. Morton, "Teaching Arithmetic", op. cit., p.7.

18. Robert L. Morton, The Teaching of Arithmetic in the Elementary Grades, op. cit., p.7.

There are two essential phases to practice or drill. Burton has discussed them as:

a. the integrative phase in which perception of the meaning is developed.

b. the repetitive, refining or facilitating phase in which precision is developed.

> The integrative phase .... demands varied practice which means many functional contacts and exploratory activities. The refining phase.... demands repetitive practice. Varied practice by itself yields efficiency but not meaning. Competent varied practice in early stages will reduce greatly the amount of repetitive practice needed later.[19]

Glennon and Hunnicutt have said that from research studies:

> .....has come a major guiding principle in the use of repetitive practice; it must be preceded by a thorough program of instruction aimed at the building of meanings or understandings, or stated otherwise, practice must follow understanding.....
>
> The teacher can feel very confident that there is a place for practice, both integrative and repetitive, in the modern arithmetic program.[20]

THE IMPORTANCE OF SPEED

The value of speed as a measure of arithmetical ability has been somewhat minimized in recent years. Instead of speed "the need for giving more consideration to the process

19. William H. Burton, The Guidance of Learning Activities, (New York: Appleton-Century-Crofts, Inc.,1944), quoted in Glennon and Hunnicutt, op. cit., p.24.

20. Glennon and Hunnicutt, op. cit., pp. 24 - 25.

of learning arithmetic has been emphasized."[21]

Dr. Schonell in writing on this subject has said:

> The teaching of ... number would greatly benefit if we allowed children the time to really understand and assimilate, indirectly and informally, at their own pace and through carefully planned experiences, the fundamental concepts of the..... subject, namely, the meaning of numbers. This slower, wider approach will repay later on.[22]

Brownell has pointed out that:

> ....measures of rate and of accuracy do not tell us how good a performance is, whether it is expert or amateurish, mature or immature, close to the limit of possible improvement or near the first stages of learning. To restrict research data on learning to measures of rate and accuracy is to portray learning incompletely.
>
> To neglect the processes employed in learning, while it is characteristic of research to do so, is to tell only one part of the story, - and possibly the less important part at that.[23]

Research has sought to establish the rate at which a particular child should work. The conclusion has been that "since no two children work best at exactly the same rate, it would seem reasonable to conclude that each child should work at his own best (but not fastest) rate."[24]

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21. Glennon and Hunnicutt, op. cit., p.27.

22. R.L. Burns, "Are We Making Arithmetic Meaningful to Children?" Macmillan Bulletin for Teachers, (Toronto: The Macmillan Company of Canada Limited), p.1.

23. William A. Brownell, "Rate, Accuracy and Process in Learning," Journal of Education Research, XXXV, (September, 1944). Summarized in Glennon and Hunnicutt, op. cit., p.27.

24. Glennon and Hunnicutt, op. cit., p.27.

Buswell, Brownell and John have said that when doing arithmetic, children should be allowed sufficient time to enable them to complete their assignments "without undue haste or unhealthful strain."[25] It has been found that "too much stimulation to work faster will induce anxiety and consequent inaccuracy. But insufficient stimulation may produce poor work habits."[26]

> Speed is not a mastery but only a symptom. Speed is not a guarantee of mastery. Emphasis on speed tends to go contrary to current emphasis on teaching pupils to be thoughtful about what they do. ....Much research has been directed toward the analysis of errors, and the results show clearly that pupils are not sufficiently thoughtful about what they do and are not sufficiently critical of the results they obtain.[27]

THE VALUE OF CRUTCHES.

From their study of meaningful versus mechanical learning in Grade Two subtraction, Brownell and Moser concluded that:

> .....the crutch in subtraction greatly facilitated learning in the initial stages. At later stages many children tended to drop it in favor of more

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25. G.T. Buswell, W.A. Brownell, and Lenore John, Teachers' Manual for Living Arithmetic Grade Three Revised Edition, (Toronto: Ginn and Company, 1947), p. iii.

26. Glennon and Hunnicutt, op. cit.,p.27.

27. Robert L. Morton, "Teaching Arithmetic", op. cit., p.27.

> mature procedures, while others had to be encouraged by the teacher to discontinue its use.[28]

Glennon and Hunnicutt have generalized that if a crutch makes for economy in learning or facilitates the development of understandings and maturer ways of handling numbers, its use should be encouraged.[29]

THE PLACE OF SUPPLEMENTARY INSTRUCTIONAL MATERIALS IN OUR MODERN ARITHMETIC PROGRAMME

In order to make arithmetic socially significant and mathematically meaningful to children, the modern teacher in the elementary school classroom is making increased use of a wide variety of supplementary instructional materials. Studies on the values of such devices in the teaching of arithmetic "support the oft repeated statement that what is needed to improve learning in this subject is not a new set of materials, but better use of the materials we already have."[30]

Educators agree that abstract ideas of number, or the names and symbols used in arithmetical computations are best

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28. William A. Brownell and Harold E. Moser, Meaningful Versus Mechanical Learning: A Study in Grade II Subtraction, Duke University Research Studies in Education, No.8, (Durham, N.C.: Duke University Press, 1949), quoted in Glennon and Hunnicutt, op. cit.,p.20.

29. Glennon and Hunnicutt, op. cit.,p.20.

30. "Research in Arithmetic", Canadian Research Digest, Vol. I, No. 2, (Spring, 1959), p.60.

developed through the use of concrete materials, and that these basic understandings are achieved best when manipulation precedes or is combined with a teaching of the computations.

> Reliable research is available to show that not only is an abundance of informal number experiences indispensable for understanding abstract numbers later, but that such activities actually enable teachers to save time through more economical learning by pupils as they advance through the grades. Dependable research furthermore has revealed that most difficulties in arithmetic in the later grades can be traced directly to inadequate development of number concepts in the primary grades. Intelligent use of number skills cannot be achieved unless these skills have been acquired by intelligent methods.
>
> Current instructional practice in arithmetic places less emphasis on the early mastery of a large number of facts, particularly in the first two grades, and more emphasis on the development of understanding. Research has shown that it is better to place emphasis at first on various oral and informal number experiences which will result in learning these facts more easily and meaningfully later.[31]

The experts agree that concrete materials help children to arrive at generalizations.

Grossnickle, *et al*, have said that:

> .... learning number consists in an orderly series of experiences which begins with concrete objects and progresses toward abstractions. There are different stages, levels, or steps which may be identified in the learning process in arithmetic. These levels or steps are as follows:
>
> 1. Readiness for learning
> 2. Laboratory period for discovery
> 3. Verbal and symbolic representation of a quantitative situation

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31. Arithmetic Grades I - VI, *op. cit.*, pp. 12 - 13.

4. Systematic verbal presentation
5. Adult level of operation.[32]

They identify four classes of instructional materials: (a) real experiences, (b) manipulative materials, (c) pictorial materials, and (d) symbolic materials.[33]

Grossnickle, Metzner and Wade have said that a child learns the meaning of a number by manipulating objects so that he can have a visual picture of it. Frequent use of concrete materials throughout the grades

> ....prevents the too common divorce between skill in computation and skill in problem solving. Children accustomed to using concrete materials know when, as well as how to add, subtract, multiply or divide. Such children reduce fractions to lowest terms by interpreting a number situation meaningfully, rather than by applying a mathematical rule to an imperfectly understood symbol.[34]

Dienes, a lecturer in mathematics at the University of Leicester, England, is presently experimenting with a piece of concrete material which he refers to as the Multibase Arithmetic Blocks. He claims that he is finding these blocks useful in accelerating the formation of notational concepts in young children.

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32. Foster E. Grossnickle, _et. al._, "Instructional Materials for Teaching Arithmetic", _Fiftieth Yearbook of the National Society for the Study of Education_, Part II, (Chicago: University of Chicago Press, 1951), p.156.

33. Grossnickle _et al._, _loc. cit._

34. Grossnickle, Metzner and Wade, _op.cit._, pp. 3-4.

The apparatus consists of pieces of wood, articulated on all faces into little unit squares. Volumes of the pieces are in ascending geometrical progression, with common ratios of three, four, five, six or ten. It is Dienes' contention that by manipulating the blocks, by exchanging equivalent amounts of wood in different shapes, by building a number of small pieces into a larger piece, by splitting a larger piece into smaller pieces, young children can be led toward the concept of carrying in addition and multiplication situations, and toward efficiency in solving problems involving difficult subtraction and formal division.

According to Dienes , mathematical concepts can be caused to develop in young children much more adequately through the use of the Multibase Arithmetic Blocks than through the use of the Cuisenaire materials. He asserts that a child taught by means of the Cuisenaire rods is far less ready for abstract mathematical thinking than one taught by means of the multibase blocks would be.

Although Dienes has observed children working with the multibase blocks in a number of schools, he is not yet able to draw any hard and fast conclusions as to the practical working of the scheme under actual school conditions. However, from his observations, he claims to have gleaned sufficient evidence to suggest that through the use of these blocks, mathematics can be introduced to a larger section of the child population than has hitherto been thought practical or possible.[35]

A DESIRABLE GRADE ONE PROGRAMME

In an attempt to determine what the authors of current arithmetic series consider a desirable programme for Grade One, the writer made an analysis of the Grade One programmes of ten arithmetic series. (Appendix A.) Included in the analysis were the programmes of the two series used in the experiment reported in this thesis. The Living Arithmetic[36] Series and the Cuisenaire[37] series, and the programmes of eight additional series: Numbers Tell Their Story[38], Understanding Arithmetic[39], Exploring Arithmetic[40], The Basic Mathematics Programme[41], Making Sure of Arithmetic [42],

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35. Z.P. Dienes, "The Growth of Mathematical Concepts in Children Through Experience", Educational Research, Vol. II, No.1,(November, 1959), pp. 9 - 28.

36. Buswell, Brownell and John, op. cit.

37. Cuisenaire and Gattegno, op. cit.

38. M.E. Lazerte, J.D. Dey, and R.M. Svidal, Numbers Tell Their Story, Grade One, (Toronto:Clarke,Irwin and Company, 1958).

39. A.L. Sanders, et.al., Understanding Arithmetic, Grade One, (River Forest, Illinois: Laidlaw Brothers, 1956).

40. H.F. Spitzer and M. Norman, Exploring Arithmetic, I, (St. Louis: Webster Publishing Company, 1958).

41. A. Riess, M.L. Hartung and C. Mahoney, Numbers We See, The Basic Mathematics Programme, (Toronto: W.J. Gage and Company, 1948).

42. R.L. Morton and M. Gray, Making Sure of Arithmetic, Book One, (Toronto: W.J. Gage and Company).

Number Round-Up[43], Arithmetic in My World[44], and Find out About Numbers[45], the Grade One book of the Carpenter Clark Series.

The writer found that all ten series attempt to lead the child to see sense in the arithmetical processes learned, and that all the series except Cuisenaire have in addition to this mathematical aim, a social aim. They seek to ensure that the arithmetic the child learns will be useful in his daily life.

All ten series emphasize the reading and writing of numerals. Six of the series include the reading and writing of numerals to one hundred, two series to fifty, one series to ten, and one series to nine.

All ten series include instruction in the language of arithmetic, but the emphasis varies greatly with the different series. In the ten series analyzed there are a total of:

19 verbal concepts of quantity

26 verbal concepts of position

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43. K.E. Collins and R. Chivers, Number Round-Up, I, (Toronto: John C. Winston Company, 1957).

44. C.N. Stokes, B. Adams and M.B. Bauer, Arithmetic in My World, I, (Boston: Allyn and Bacon, Inc., 1958).

45. D. Carpenter and M.K. Clark, (Find Out About Numbers), Toronto: Brett-Macmillan Ltd., 1957).

25 verbal concepts of size

11 verbal concepts of subtraction

3 verbal concepts of addition

14 miscellaneous verbal concepts

This makes a grand total of 101 verbal concepts in all. The number of verbal concepts introduced in the Grade One programme in each series varies from eight in the Carpenter Clark series to forty-five in Arithmetic in My World.

In two of the series, Exploring Arithmetic and The Basic Mathematic Programme, the whole of the Grade One Programme is concerned with readiness for number. In both of these series the emphasis at the Grade One level is upon activities using actual objects where possible, supplemented by visual experiences, instead of upon dependence on learning through drill with abstract number symbols. No formal instruction on how to add or subtract is included in these Grade One programmes. In these two series the emphasis at the Grade One level is not on mastery of content but on fostering readiness for the more formal work of succeeding grades. Hence the programmes are designed to encourage the children to make discoveries about numbers and number relationships, and to think of numbers as a useful means of dealing with the world around them, rather than to emphasize mastery of facts.

The Grade One programme of Exploring Arithmetic stresses counting. The children learn to count by ones to one hundred, by two's to thirty-two, by threes to eighteen, by fours to twenty, by fives to fifty, as well as reversed counting from twenty to one. Of all the series analyzed this series places the greatest emphasis upon counting. Through counting by two's, threes, fours and fives, the simple multiplication and division facts are understood, but no drill with abstract number symbols takes place.

In Numbers We See, the Grade One book of the Basic Mathematics Programme, the children learn the multiplication and division facts of the numbers one to ten through grouping. They see nine objects as 2,2,2,2, and 1,or as 4,4, and 1; but there is no formal drill on the multiplication and division facts of the numbers.

At the opposite extreme to these two programmes is the Cuisenaire programme. The First Grade Cuisenaire programme is designed to perfect computational skill and mathematical understanding of all the relationships among the first ten numbers. Children following this programme are expected to have at the end of the first year of school a precise and systematic knowledge of the first ten numbers. This includes an understanding of all the factors and of all the relationships of, and between, these numbers - - all the addition, subtraction, multiplication and division facts, plus all the fractional parts of the numbers.

Seven of the series analyzed include the concept of one-half of an object in their Grade One programmes, and three include the concept of one-half of a group. Only the Cuisenaire course includes an understanding of fractional parts of abstract numbers. All the fractional parts from 1/2 to 10/10 are included in Book One of the Cuisenaire programme.

All the series except Cuisenaire include rational counting of objects. The number of objects counted varies from a total of eight in Arithmetic in My World to one hundred in Exploring Arithmetic.

In all of the series except Exploring Arithmetic and The Basic Mathematics Programme, which are readiness programmes, formal addition and subtraction are included in the Grade One programmes. The sums and minuends vary from six in three of the series to ten in three of the other series.

Four of the ten series include some knowledge of multiplication and division facts in the Grade One programme, but only the Cuisenaire series calls for automatic response of these facts. In the other three series, the multiplication and division facts are learned as groups such as that 2 groups of 4 objects make 8, 3 groups of 3 objects make 9, or that 9 objects can be placed in 4 groups of 2 and there will be 1 left.

All of the series except the Cuisenaire include work on oral problems involving addition and subtraction facts. Three series include problems involving multiplication facts, six, problems involving telling time in hours; nine, problems in the reckoning of money; five, problems in linear measurement; three, problems in liquid measure; and two, problems involving pounds and ounces.

The writer found the Grade One programmes of Numbers Tell Their Story, Understanding Arithmetic, Making Sure of Arithmetic, Number Round-Up, Living Arithmetic, Arithmetic in My World, and Carpenter Clark, quite similar in content. In all seven series, instruction proceeds through the concrete stage using natural and representative materials where possible, to the semi-concrete stage using pictures of natural and representative materials, to the abstract stage using numbers to stand for groups.

In the Exploring Arithmetic and The Basic Mathematics series, in which the Grade One programmes are entirely devoted to readiness, this last stage of using abstract numbers to stand for groups is deferred until Grade Two.

Cuisenaire is the only one of the ten series analyzed that does not include in the first year's programme any work on counting or enumerating, any work on oral problems, or any work on the relative value of the different coins. It is also unique among the series in that it stresses automatic response of multiplication and division facts and an understanding of fractions using abstract numbers.

The writer sought to establish how closely the ten series analyzed had implemented in their Grade One programmes, the findings of recent research in arithmetic.

A Planned Curriculum: In all ten series, arithmetic instruction proceeds on a systematic planned basis.

Meaning: In all ten series, an attempt is made to develop an understanding of number relations and of the number system. In none of the series is there any attempt made to have the child memorize number facts or number processes which are not first understood. In all the series more emphasis is placed on understanding than on mastery of a large number of facts.

Drill: In the eight series which include the learning of some addition and subtraction facts in the Grade One programme, much drill and practice are provided to maintain the skills and abilities originally taught by meaningful methods.

Speed: In none of the series, with the exception of Cuisenaire, is rapid recognition of number facts stressed at the Grade One level. Rather, the child is led slowly to an understanding of the fundamental concepts of number.

Crutches: The only crutch used at the Grade One level in the programmes analyzed, is counting. In all of the series except Cuisenaire, the child is allowed to count objects or pictorial representations of objects to assist him in his comprehension of the number facts.

Concrete Materials: In all the series analyzed, concrete materials are used. Cuisenaire makes the greatest use of manipulative materials, through its set of rods. The Numbers Tell Their Story series makes use of manipulative materials in the form of bead frames, and also uses concrete and pictorial representations of concrete materials for counting and grouping. Of the remaining eight series, five make use of concrete, pictorial and symbolic materials, and three use only concrete and pictorial materials, - the symbolic materials being reserved for the next grade.

After analyzing the Grade One programmes of these ten series, the writer generalized that except for some deviations in the Cuisenaire series, all have implemented in their arithmetic programmes the findings of research studies of recent years.

EXPERIMENTS INVOLVING THE USE OF CUISENAIRE MATERIALS.

The first controlled experiments reported in Canada involving a comparison of the Cuisenaire method with other methods of teaching arithmetic at the Grade One level were instituted in Vancouver, British Columbia, in the fall of 1957. During the following year the Saskatchewan Teachers'

Federation, in cooperation with the Department of Education for Saskatchewan, instituted an experiment on a larger scale. The writer knows of no experiments of this type having been done in the United States. In Europe the most comprehensive survey reported was conducted in Edinburgh, Scotland during the school year 1957 to 1958.

THE VANCOUVER EXPERIMENTS

In the fall of 1957 an experiment to evaluate the effectiveness of Cuisenaire materials in the teaching of Grade One arithmetic was instituted by the Department of Research and Special Services of the Board of School Trustees, Vancouver, British Columbia. One experimental Grade One class and one control Grade One class were selected from each of five designated schools in Vancouver. Each of the experimental classes was supplied with four sets of Cuisenaire rods, and instruction began simultaneously in these classes early in October.

For both the experimental and control classes instruction was limited to twenty minutes daily: ten minutes teaching followed by ten minutes seatwork.

The following tests were administered to all the children in the experiment:

1. The Detroit Beginning First-Grade Intelligence test, in September, 1957.
2. An initial survey test in numberwork, in January 1958. (Appendix B).

3. A terminal test based on the prescribed course of numberwork for Grade One, in June, 1958. (Appendix C). This test was prepared by the primary supervisor and the primary consultants. The difference between a pupil's score on this test and his score on the initial survey test in January, was taken as a measure of his gain in number skills.
4. A survey test, in June, 1958, of the content taught with Cuisenaire materials. (Appendix D).

The mean scores for these tests are shown in Table 1.

Although the mean scores on the Detroit test and the mean gain in basic numberwork were higher for the experimental groups than for the control groups, in neither case was the difference found to be statistically significant. The difference in the mean scores on the survey test of the content taught with Cuisenaire arithmetic, however, was found to be highly significant. The superior performance of the experimental classes on this test was attributed to the fact that these classes were taught with Cuisenaire materials while the control classes were not.

A comparison was made of the relative effectiveness of traditional and Cuisenaire methods with bright and slow pupils. The Cuisenaire materials were shown to be more

TABLE 1. Mean Scores on the Detroit Intelligence Test, on Tests in Grade One Numberwork, and on the Cuisenaire Numberwork Test.*

School	Class	Number of Cases	Mean Detroit I.Q.	Mean Score Initial Test	Mean Score Final Test	Mean Gain in Basic Number-work	Mean Score Cuisenaire Test
School #1	Control	16	105.56	19.75	29.94	10.19	12.63
	Experi-mental	19	113.05	18.47	30.05	11.58	26.05
School #2	Control	25	109.72	14.48	22.05	7.60	9.64
	Experi-mental	27	108.00	15.26	25.74	10.48	14.44
School #3	Control	23	108.09	12.95	22.65	9.70	9.35
	Experi-mental	26	110.23	14.42	24.00	9.58	21.73
School #4	Control	30	112.60	17.23	32.86	15.63	18.03
	Experi-mental	28	115.86	17.28	28.96	11.68	28.29
School #5	Control	21	102.14	15.38	22.38	7.00	6.52
	Experi-mental	22	108.23	16.46	28.82	12.36	23.45
All Schools	Control	115	108.18	15.79	26.16	10.37	11.62
	Experi-mental	122	111.11	16.26	27.33	11.07	22.61
	Both	237	109.69	16.03	26.76	10.73	17.27

* "A Report on an Experiment to Evaluate the Effectiveness of Cuisenaire Materials in the Teaching of Grade One Numberwork," (Department of Research and Special Services, Board of School Trustees, Vancouver, B.C., September, 1958), (Mimeographed), p.1.

effective than traditional ones with bright and slow children alike when the scores on the Cuisenaire test were used as the criteria.

The following conclusions were reached:

1. There was no significant difference between the experimental and control groups in their rate of learning the basic Grade One numberwork. Children in the Cuisenaire classes did not suffer any "set-back" in the basic Grade One numberwork because they were members of the experimental groups.
2. Children in the experimental classes far surpassed the controls in facility with more complex combinations of whole numbers and common fractions such as are outlined in the Cuisenaire manual.
3. On the basis of their performance on two problem items that required the ability to read and to reason, there was no significant difference between the experimental and control groups.
4. In terms of gains in scores on tests of basic Grade One numberwork, the effectiveness of the method of instruction is independent of whether the group is bright or slow.[46]

Selwyn A. Miller, Director of the Department of Research and Special Services for the Board of School Trustees, Vancouver, cautioned that in interpreting the results of this experiment, the following limitations should be considered.

1. The restricted length of time for the experiment. It may be that the period for the gains in "basic number skills" was not sufficiently long.

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46. "A Report on an Experiment to Evaluate the Effectiveness of Cuisenaire Materials in the Teaching of Grade One Numberwork," (Department of Research and Special Services, Board of School Trustees, Vancouver, B.C., September, 1958), (Mimeographed). p.2.

2. The restricted size of the samples.
3. The absence of refined standardized tests suitable and valid for this research.
4. The difficulty of equating "teacher-ability".
5. The necessary delay for the initial test to enable the pupils to develop an understanding of written symbols in arithmetic.
6. The limited supply of Cuisenaire materials.
7. The possible inequality of motivation. It may be that the attractiveness of Cuisenaire materials heightened the interest of pupils in arithmetic. Furthermore, the mere specialization of procedures and materials for the Cuisenaire classes may have produced a motivational bias in their favour.
8. The restriction of locations of classes.
9. The relative inexperience of the teachers with Cuisenaire materials. 47

The following year, a second experiment at the Grade One level was conducted in the Vancouver schools. One experimental and one control class in each of eight schools participated in the experiment. Each experimental class was supplied with eight sets of Cuisenaire rods instead of four as in the previous year. The same procedures were followed as in the 1957 - 58 experiment regarding time spent on the teaching of arithmetic and on arithmetic seatwork, and the same intelligence, survey and terminal tests were used.

The results of the tests for the 1958 - 59 experiment are shown in Table 2. These results were very similar to those of the previous year. Although the mean scores on

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47. Ibid, p.2.

TABLE 2. Mean Scores on the Detroit Intelligence Test and on Tests in Grade One Numberwork.*

School	Class	Number of ** Pupils	Mean Detroit I.Q.	Standard Deviation of Detroit I.Q.	Mean Score Initial Test	Mean Score Final Test	Mean Gain in Basic Numberwork	Standard Deviation of Mean Gain
School #1	Control	21	107.95		18.71	23.57	4.86	
	Experi- mental	21	116.71		18.95	29.90	10.95	
School #2	Control	25	97.96		21.56	29.40	7.84	
	Experi- mental	21	107.33		17.33	25.81	8.48	
School #3	Control	23	115.17		15.83	22.57	6.74	
	Experi- mental	27	109.63		17.96	29.07	11.11	
School #4	Control	27	115.41		17.07	28.00	10.93	
	Experi- mental	27	118.36		23.11	34.37	11.26	
School #5	Control	23	113.78		18.35	22.17	3.82	
	Experi- mental	20	107.40		12.50	15.60	3.10	
School #6	Control	17	112.41		21.88	30.82	8.94	
	Experi- mental	21	109.10		13.10	22.48	9.38	
School #7	Control	28	108.11		18.68	31.79	13.11	
	Experi- mental	26	116.81		21.50	31.81	10.31	
School #8	Control	20	101.90		17.85	27.85	10.00	
	Experi- mental	16	106.94		19.69	31.00	11.31	
All Schools	Control	184	109.10	16.38	18.65	27.10	8.45	6.61
	Experi- mental	179	111.98	15.07	18.27	27.88	9.61	6.02
	Both	363	110.52	15.81	18.46	27.48	9.02	6.36

* "A Report on Two Experiments Conducted During the 1958 - 59 School Year to Evaluate the Effectiveness of Cuisenaire Materials in Teaching Primary Numberwork", (Department of Research and Special Services, Board of School Trustees, Vancouver, B.C., September, 1959), (Mimeographed) p.2.

** Only those pupils were included who were present for all of the tests.

the Detroit test and the mean gain in basic numberwork were higher for the experimental groups than for the control groups, in neither case was the difference found to be statistically significant. The difference in the mean scores on the test of Cuisenaire learnings once more proved to be very significant.

A study was made of the correlations between mental ability and achievement in numberwork. Using the Pearson Product-Moment Method, the coefficient of correlation between intelligence quotients on the Detroit tests and gains in scores on the test in basic numberwork was found to be:

Control group	r = + .1225
Experimental group	r = + .3156
Combined	r = + .2158

Using the same method, the coefficient of correlation between intelligence quotients on the Detroit tests and scores on the Cuisenaire test, were shown to be:

Control group	r = + .3415
Experimental group	r = + .5765
Combined	r = + .3684

These results revealed:

1. a higher correlation in both instances for the experimental group than for the control group.
2. lower correlations between intelligence quotients and gains in scores on the tests of regular Grade I numberwork than between intelligence quotients and scores on a test of Cuisenaire numberwork.

> This result may be due, in part, to the fact that in the first instance, the criterion is the difference between two scores, while in the second, it is a single score. Furthermore, the periods of time for these two achievement criteria were not the same.[48]

A comparison was made of the relative effectiveness of traditional and Cuisenaire methods with bright pupils and with slow pupils. (Table 3).

An analysis of variance on these scores revealed that:

> 1. a highly significant relationship existed between ability and achievement,
> 2. the difference between the achievement of groups taught by different methods was not significant, and
> 3. the relative effectiveness of a particular method of instruction (Cuisenaire or traditional) is independent of whether the group is bright or slow. Cuisenaire materials appear to be no more effective with bright children than with slow children in bringing about a gain in the scores on tests of basic grade one numberwork.[49]

After two years of experimentation with the Cuisenaire method of teaching arithmetic the Department of Research and Special Services, Vancouver, British Columbia, reached the following conclusions:

> 1. Children who have been taught with Cuisenaire materials in Grade One gain remarkable facility in the complex manipulation of whole numbers and fractions and, at the same time, they make progress in the prescribed course of numberwork that is at least as good as that made by those pupils who are taught by traditional methods. To say the least,

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48. Ibid, p.3.

49. Ibid, p.4.

Cuisenaire materials appear to be valuable visual and tactile aids to learning.

2. Cuisenaire materials appear to be no more effective with bright children than with slow children.

3. Primary consultants and teachers who have used Cuisenaire materials are enthusiastic about their value.[50]

TABLE 3. A Comparison of the Performance of Slow* Pupils and Bright** Pupils in Both Groups.***

Category	Number	Treatment Group	Mean I.Q.	Mean Gain in Test Score on Basic Number-work.
Bright	32	Experimental	132.5	21.3
Bright	32	Control	130.3	19.4
Slow	32	Experimental	91.6	16.4
Slow	32	Control	88.4	15.9

* Four Pupils from each class with the lowest I.Q.'s)
** Four Pupils from each class with the highest I.Q.'s)
*** <u>Ibid</u>. p.4.

THE SASKATCHEWAN EXPERIMENT

During the academic year 1958 - 59 the Saskatchewan Teachers' Federation in cooperation with the Department of Education for Saskatchewan conducted an experiment to

50. "A Report on Two Experiments Conducted During the 1958 - 59 School Year to Evaluate the Effectiveness of Cuisenaire Materials in Teaching Primary Numberwork", (Department of Research and Special Services, Board of School Trustees, Vancouver, B.C., September, 1959), Mimeographed), p.6.

evaluate the Cuisenaire method of teaching arithmetic to primary children.

Four hundred and sixty-one Grade One children in the Province of Saskatchewan were taught by the Cuisenaire method during a ten month period commencing in September, 1958. Their achievement was measured and compared with that of 263 other Grade One children in the Province of Saskatchewan who were taught by the traditional method employed at that time in Saskatchewan.

A Power Test (Appendix E) prepared by Mr. F. Gathercole, Superintendent of Public Schools, Saskatoon, and Dr. F. Deverell of the College of Education, University of Saskatchewan, was used as the criterion of achievement. This test was administered three times in the course of the year. A special test, (Appendix F), containing slightly more work involving the use of fractions than the Power Test had contained, was prepared by Mr. F. Gathercole and Dr. F. Deverell. This test was administered at the end of June. The children in the experiment were tested for mental ability through the use of the Pintner Ability Test.

The results of the experiment are summarized in Table 4.

The statistical results indicated that the experimental group which was somewhat behind in November, was even with the control group at the end of June using the combined results of the Power Test and Special Test as the criteria.

The Central Committee which was set up to assess the results of the experiment agreed that the results were not outstandingly significant; but they recommended that the project be carried on for at least one more year.[51]

TABLE 4. Final Summary of Experiment Conducted by the Saskatchewan Teachers' Federation and the Department of Education on the Cuisenaire Method of Teaching Mathematics 1958 - 59.*

Group	Number of Pupils	Average I.Q.	Average Score on Power Tests and Special Test			
			Power Tests			Special Test
			Nov.	Apr.	June	June
Experimental	461	105.8	16.9	35.5	49.5	47.7
Control	263	105.2	21.5	41.0	51.3	46.0

* "Cuisenaire, A Sound Approach to Teaching Mathematics", (The Saskatchewan Teachers' Federation and the Department of Education, Saskatchewan), p.3. (Mimeographed).

THE EDINBURGH EXPERIMENT

During an eighteen month period commencing at the beginning of the 1957 - 58 session, the Edinburgh Corporation Schools conducted an experiment to ascertain the effectiveness of teaching arithmetic to Primary I children with the

51. "Cuisenaire, A Sound Approach to Teaching Mathematics", (The Saskatchewan Teachers' Federation and the Department of Education, Saskatchewan), (Mimeographed). p.7.

aid of the Cuisenaire materials as compared with teaching conducted without the materials.

The experimental group consisted of a class of forty boys in one school; the control group consisted of a class of fourteen girls and twenty-four boys in another school.

> ...The control group was chosen to be as closely equivalent as possible to the experimental group in respect of the potential ability of the pupils concerned and of the educational stimulus provided both at home and at school. This choice was made by the Assistant Director of Education of the City of Edinburgh in the light of his knowledge, over several years, of the two schools concerned.[52]

To ascertain how closely equivalent the two groups were matched in mental ability, the Thurstone Primary Mental Abilities Test, and the Moray House Picture Test were administered to the seventy-eight children in the experiment, at the end of the eighteen months period. To test achievement in arithmetic use was made of six sections of Schonell's Diagnostic Arithmetic Test, (Appendix G) and of a specially designed test of simple mechanical and problem sums involving vulgar fraction such as, 1/4, 4/9, 1/6, 2/5 and 3/8. The results of these comparisons are summarized in Table 5.

The mean scores of the two groups on all the tests were exceedingly close. None of the differences was shown to be statistically significant at the five per cent level. Regarding the standard deviation, the scores of

52. D. Karatzinas and T. Renshaw, "Teachers' Views of the Cuisenaire Method", reprinted from *The Scottish Educational Journal*, (October 3, 1958) by the University of Edinburgh, Department of Education), p.6.

the experimental group were more closely grouped at the top end of the scale than were those of the control group.

TABLE 5. Mean Scores and Standard Deviation on the Moray House Picture Test, on Thurstone's Test of the "Primary Mental Abilities", and on Schonell's Diagnostic Arithmetic Tests.*

Test	Mean Score and Standard Deviation			
	Control Group		Experimental Group	
Moray House Picture Test II (Quotient)	109.2	10.4	108.3	10.1
Thurstone's Test of the "Primary Mental Abilities"				
Verbal	39.9	3.2	39.8	3.5
Perceptual	21.8	4.8	20.2	5.4
Numerical	22.7	2.4	22.3	2.3
Motor	38.8	7.6	36.9	6.4
Spatial	18.3	2.9	18.1	2.7
Schonell's Diagnostic Arithmetic Tests.				
Addition	98.5	3.4	98.3	2.5
Subtraction	95.5	6.9	94.3	7.9
A to E Addition	36.6	6.1	37.1	3.1
A to D Subtraction	25.2	7.2	25.9	5.7
**A to K Multiplication			36.7	4.5
**A to K Division			32.3	5.4
**Fraction Test (20 sums)			13.8	5.1

* *Ibid* p.6.

** The control groups had not made sufficient progress to be able to attempt these three tests.

In summing up the results of the experiment, Karatzinas and Renshaw point out that an earlier start was made by the experimental group in learning to multiply and divide and to work out sums involving fractions, a start which was well consolidated during the period of the investigation. They also point out that at the end of the period of investigation the experimental group had gained a no less effective mastery than had the control group over the processes of addition and subtraction, in spite of the fact that so much of their time had been spent on multiplication, division and working with fractions.[53]

OBSERVATIONS MADE BY DR. WILLIAM BROWNELL

In June, 1959, Dr. William A. Brownell, Dean of the School of Education, University of California at Berkeley, spent two weeks in the publicly maintained schools of England and Scotland with the express purpose of seeing for himself what was happening in the schools that were experimenting with Cuisenaire and with Stern apparatus.[54] He found that only about 2.6% of all the schools in England and Wales were using the Cuisenaire materials and teaching the Cuisenaire programme, and that only about 1.6% were using the Stern materials and teaching the Stern programme.

Dr. Brownell found that the Cuisenaire method was much more popular in Scotland than in England and Wales. He was told by the Central Administration Office, Edinburgh,

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53. Ibid, p.6.
54. Dr. Catherine Stern, Director, Castle School, New York City, has evolved a scheme of work and produced a vari-coloured set of number apparatus - coloured blocks measuring one unit, two units, three units and so on to ten units.

Scotland, that by the end of 1959, fifty-nine of Edinburgh's seventy-nine elementary schools, and all of the elementary schools in Glasgow would have adopted the Cuisenaire programme.[54] In his report, Dr. Brownell made no mention of finding any 'Stern schools' in Scotland.

Dr. Brownell did not attempt to compare the effectiveness of Cuisenaire or Stern with the traditional programmes of instruction, but from what he observed of children in the British schools being taught by these two methods he drew three conclusions:

1. The attention span of school beginners has been seriously underestimated. He noted that although beginners in American schools are not expected to remain interested in any activity for more than fifteen to thirty minutes, in English and Scottish schools Infant School children work happily, busily, and effectively with Cuisenaire or Stern apparatus for periods of an hour or more.
2. The 'readiness' of school beginners for systematic work in arithmetic has been seriously underestimated. He noted that although many American educators consider that school beginners are unready for arithmetic, in English and Scottish schools the children

54. William A. Brownell, "Observations of Instruction in Lower-Grade Arithmetic in English and Scottish Schools", The Arithmetic Teacher, (April, 1960), Vol. VII, No.4, pp. 165 - 168.

are ready for systematic instruction in arithmetic at the age of five.

3. Children in the lower grades can be safely asked to learn much more arithmetic than they are now being asked to learn. Dr. Brownell noted that whereas American educators have been satisfied if children learned the addition and subtraction facts and inuends to fifteen during the first two years of school, the teachers in England and Scotland whom he observed teaching the Cuisenaire and Stern methods went far beyond this. He said that he observed these teachers teaching things in arithmetic which we in America KNOW young children cannot learn. His observations left him convinced that we can teach more arithmetic than we now teach in the first few grades, and teach it faster if we wish to do so.[55]

Although Dr. Brownell found that children in the British schools who were being taught by the Cuisenaire or Stern methods were learning more arithmetic in the first few years than American children being taught by traditional methods, he questioned the value of confronting young children with such demanding tasks as, "Simplify the expression $X^2 + 6X + 8$". He asked whether we should or should not undertake to develop

55. Ibid, pp. 173 - 174.

in young children the mature kinds of mathematical skill and relationship now taught in some of the British schools.[56] He also asked to what extent radically new materials and methods should be substituted for those in common use in America today.

Although Dr. Brownell admitted that the British children that he observed being taught by the Cuisenaire or Stern methods had very unusual mathematical accomplishments for their age, he was not willing to admit that these accomplishments could be attributed wholly to the materials and methods employed. He noted that:

1. The most successful classes were taught for extremely long periods of time daily.
2. The teachers of these classes were fired with enthusiasm for change, and this special enthusiasm unquestionably carried over into better planned and more inventive procedures possible with the new materials but not dependent upon them.
3. For the experimental classes the mathematical outcomes set for realization were of a markedly different character from those sought in typical classes. In other words, the experimental teachers were seeking goals unlike those of the non-experimental teachers.[57]

Although Dr. Brownell considers that some changes in materials and methods now in general use in the arithmetic programme are desirable, he does not think that they need be revolutionary. He says:

> ... At any rate, the first step is not to adopt a radically new system, however good. The first

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56. *Ibid.* p. 176.

57. *Ibid.* p. 176.

step is to decide upon the objectives of instruction and probably upon the amount of time to be given arithmetic. Then, and only then, is it appropriate to consider materials and methods. If the modified objectives can be realized more economically and more effectively through the use of materials and methods now more or less in the experimental stage, then these should be put to work. It is my judgment, however, that currently popular systems, when changed in minor ways, will be found wholly adequate for the new arithmetic.[58]

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58. Ibid. pp. 176 - 177.

CHAPTER III

OUTLINE OF THE EXPERIMENT

In the spring of 1959, Mr. A.D. Thomson, Assistant Superintendent of Schools for the Winnipeg School Division, discussed with the writer the plan suggested by Dr. W.C. Lorimer, Superintendent of Schools for the Winnipeg School Division, to experiment with the Cuisenaire method of teaching arithmetic at the Grade One level. The writer agreed to assist in the selection of the control schools, classes and teachers, to prepare and distribute questionnaires to all personnel involved in the experiment, to select or prepare the necessary intelligence, readiness and achievement tests, and to evaluate the results of the testing programme.

SELECTION AND BRIEFING OF THE TEACHERS

SELECTION OF TEACHERS FOR EXPERIMENTAL CLASSES

When the details of the experiment had been arranged, the six primary supervisors for the Winnipeg School Division, Mrs. A. Grady, Mrs. E. Maclennan, Miss A. Paterson, Miss G. Robertson, Miss K. Wilson, and the writer, were asked by Mr. Thomson to select several Grade One teachers who would be suitable and willing to experiment with a new method of teaching arithmetic.

Mr. Thomson requested that the supervisors select only teachers who met the following qualifications of ability, attitude and experience:

1. The teachers were to have had several years experience in primary work on the Winnipeg staff.
2. They were to have had some previous experience teaching their present type of class.
3. They were to be of above average teaching ability.
4. They were to have had success in teaching arithmetic by the authorized method.
5. They were to be interested in new and different approaches to learning.

In order to ensure that the classes participating in the experiment would constitute a representative sample of the total Grade One population of Winnipeg, each supervisor was asked to select one teacher from a school in a fairly low socio-economic area and one teacher from a school in a better socio-economic area. After the teachers had been selected in this manner, the cooperation of the principals of the schools concerned was solicited to make sure that the classes to which these teachers were assigned during the year of the experiment would range in ability from very low to accelerated Grade Ones.

Eleven teachers were selected and all agreed to take part in the experiment, which would commence in September, 1959 and continue until June, 1960.

BRIEFING OF TEACHERS OF EXPERIMENTAL CLASSES

The teachers chosen to teach the experimental classes, all of whom were totally unacquainted with the Cuisenaire method of teaching arithmetic, were invited to a workshop on June 12, 1959, sponsored by the Winnipeg School Division and the Manitoba Teachers' Society, and held in Rockwood School in Winnipeg. At this workshop, Mr. Hector Trout, Executive Assistant of the Saskatchewan Teachers' Federation, told of an experiment involving the use of the Cuisenaire materials which had been carried out in Saskatchewan during the year 1957 - 58. Mr. Trout, who had visited Georges Cuisenaire in Thuin, Belgium, the previous summer, and who had attended a workshop conducted by Caleb Gattegno in Saskatoon in October, 1957, outlined the Cuisenaire method and discussed the philosophy and psychology involved in the method.

Following Mr. Trout's lecture, Miss V. Watchicoski of Victoria School, Saskatoon, presented two demonstration lessons using some Kindergarten and some Grade One pupils from Rockwood School. During the lessons, Miss Watchicoski was very careful not to tell the children anything about the rods, but by allowing the children to see and to feel the various rods she led them to discover that all the rods of the same colour were the same size, and to see the relationships between the various rods.

Apart from the workshop no further in-service training was given to the teachers of the experimental classes. Before school closed in June, each teacher was supplied with a box of Cuisenaire rods, a copy of Numbers in Colour[1] and Arithmetic With Numbers in Colour Introductory Stage Book I[2] in the hope that they would find time to make themselves familiar with these materials before school opened in September.

SELECTION OF CONTROL SCHOOLS

Toward the end of August, when it was known to which type of class the teachers taking part in the experiment were to be assigned, the writer met with Mr. Thomson, to select the "controls" for the experiment.

The first problem was to select eleven schools to act as control schools. A sincere attempt was made to ensure that the control schools would be as closely equi-

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1. G. Cuisenaire and C. Gattegno, Numbers in Colour, (London: William Heinemann Ltd., 1958).

2. C. Gattegno, Arithmetic With Numbers in Colour Introductory Stage Book I, (London: William Heinemann Ltd., 1957).

valent as possible to the schools having experimental classes, in respect to total number of Grade One pupils in the schools and to socio-economic area. Each school where there was to be an experimental group was matched with another school of a similar size in a similar socio-economic area. Of the eleven control schools chosen, one was from a very high socio-economic area; two were from high; three from average; one from fairly low; one from low; and two from very low socio-economic areas.

SELECTION OF CONTROL CLASSES

The size of the school was considered of great importance. If the experimental group were to be the top Grade One class in a school with three Grade One classes, the control group in order to be comparable would also have to be the top Grade One class from among three classes. If the experimental group were to be heterogeneous, consisting of all the Grade One children in a small school with only one Grade One class, the control group would also have to be of the heterogeneous type. The control and experimental groups would also have to be matched regarding socio-economic background.

SELECTION OF TEACHERS FOR CONTROL GROUPS

When a school was found similar in size and socio-economic area to a school containing an experimental class, a matching class was chosen. If the teacher of that class were suitable to act as a control teacher, that class was selected to act as a control group. If the teacher were not suitable, another school had to be considered.

The writer knows of no workable system of merit rating a teacher and found it impossible to equate a control teacher with an experimental teacher in regard to teaching ability, enthusiasm and success in teaching arithmetic. However, in each case as with the teachers of experimental classes, the teachers of control classes were chosen only if they had had several years of experience teaching in Winnipeg schools, if they were considered by the Assistant Superintendent to be of above average teaching ability, if they were known to have had several years experience with a similar type of class, and previous success in teaching arithmetic.

In this manner, eleven schools, classes and teachers were finally selected to act as controls in the experiment.

Table 6 shows how the groups were matched in regard to number of pupils, type of class, number of Grade One classes in the various schools, and type of socio-economic area in which the schools were situated.

BRIEFING OF THOSE PARTICIPATING IN THE EXPERIMENT

As soon as school opened in September, the principals

TABLE 6. A Comparison of the Experimental and Control Classes Regarding Number of Pupils, Number of Grade One Classes in the School, Type of Class, and Area in Which School was Situated.

Name of Group	Experimental	Control	No. of Grade One Classes in the School	Type of Class	Type of socio-economic area in which school was situated.
	No. of Pupils.	No. of Pupils.			
Experimental #1	13		2	Continuing Grade Ones	Very low
Control #1		5	2	Continuing Grade Ones	Very low
Experimental #2	29		4	Average	Average
Control #2		22	2	Average	Average
Experimental #3	31		4	Average	(Fairly low. (Many new Canadians with (language problems.
Control #3		25	3	Average	as above
Experimental #4	27		2	Better of the 2	High
Control #4		27	2	Better of the 2	High
Experimental #5	36		3	Best of the 3	Average
Control #5		25	3	Best of the 3	Average
Experimental #6	33		2	Better of the 2	Very high
Control #6		33	2	Better of the 2	Very high
Experimental #7	33		2	Better of the 2	High average
Control #7		32	3	Best of the 3	High average
Experimental #8	27		2	Accelerated	Average
Control #8		27	2	Accelerated	Average
Experimental #9	29		2	Better of the 2	(Low. Many new (Canadians with (language prob-(lems.
Control #9		29	2	Better of the 2	as above

continued...

Table 6 continued.

Experimental #10	20		2	Slower of the 2	High
Control #10		31	2	Slower of the 2	High
Experimental #11	31		2	Better of the 2	Very low
Control #11		29	2	Better of the 2	Very low
Total number in groups.	309	285			
Total number in experiment	594				

and vice-principals of the twenty-two schools, and the twenty-two teachers involved in the experiment were contacted; the experiment was outlined to them and their cooperation was solicited.

The teachers of both the experimental and control classes were requested to limit the time spent in teaching arithmetic to twenty minutes per day, and the time spent by the pupils in doing arithmetic seatwork to ten minutes per day. The time of the day when arithmetic was to be taught was left to the discretion of the individual teacher. The suggestion was that it be taken immediately after Roll Call in the afternoon, but there was no compulsion about this. The teachers were informed that two Power Tests would be administered during the school year to compare the relative achievement of the control and the experimental groups. The teachers themselves did not know with which group their classes were matched.

FURTHER BRIEFING OF THE EXPERIMENTAL TEACHERS

Early in September the six primary supervisors met with the eleven teachers of the experimental classes to discuss the new method. None of the six supervisors and none of the eleven teachers had had any previous experience teaching the Cuisenaire method. The teachers were urged to study the manual and the handbook with which they had been provided and to follow them as closely as possible. They were requested to refrain from using any type of seatwork which would involve counting such as, "Colour 4 ducks blue. Colour 3 ducks red". "Make 2 big balls and 6 little balls." Instead, at the beginning of the term, they were to have the children spend the time normally devoted to seatwork in "exploring" with the Cuisenaire materials. The time thus spent would vary with the type of class.

Each experimental classroom was provided with four boxes of rods. All of the teachers with the exception of the teacher of Experimental Group Number One, which consisted of only thirteen children, considered that these were insufficient. Since the purchase price of the rods was $8.60 per box, four boxes per room, were all that could be allowed.

In December, the primary supervisors met again with the eleven teachers of the experimental classes in an attempt to resolve some of the fears and difficulties being experienced. By this time, through using the trial and error approach and by closely following the handbook provided, the teachers had discovered for themselves ways and means of handling the materials effectively and of utilizing their time profitably. Seatwork no longer presented a problem because the children were able by this time to copy questions from the blackboard and to fill in answers on mimeographed sheets. The teachers willingly shared their experiences and ideas with one another. Their chief worry seemed to be that they were not progressing quickly enough, that they would never cover the prescribed course by the end of June, and that they had allowed the children to spend too much time at the beginning of the term exploring with the rods.

PROCEDURE

For ten months, from September 1959 until June 1960, the children in the experimental groups were taught arithmetic by the Cuisenaire method exclusively. Their progress was measured against that of the control groups who were taught arithmetic in the traditional way.

At the beginning of the experiment there were 309 children in the experimental groups, and 285 in the control groups. Seventy-nine in the experimental groups and 96 in the control groups were eliminated through absence from one or more of the four tests administered throughout the year. Experimental Group Number One was dropped due to the resignation of the teacher in April. This necessitated the deletion also of the matching control group. The number of children present for the complete testing programme (Table 7), was 230 in the experimental groups and 189 in the control groups.

REPORT OF THE TESTING

Four tests were administered during the experiment, an Arithmetic Readiness Test in September, a Power Test in March and the same test again in June, and an Intelligence Test in May.

THE READINESS TEST

After the twenty-two teachers and classes had been selected to take part in the experiment, the next problem encountered was to determine what number skills the testees possessed. It was decided to use Pretest 1, Form B, from

Jolly Numbers[3]. Permission to duplicate this test is given in the manual[4], and multigraphed copies of the test were made. (Appendix H). The Readiness Test included three items on identification, three on reproduction, seven on crude comparison, and three on exact comparison, - a total of sixteen items in all.

Directions for administering the test (Appendix I) were prepared by the writer.

The Readiness Test was given to the 594 children in the experiment immediately following the Opening Exercises on the mornings of September 9, 10 or 11 by the classroom teachers. The answer sheets were marked by the teachers and checked by the writer.

The great majority of the children in the experiment had had a year of kindergarten training in the Winnipeg schools and had had a considerable amount of informal number experience during that time. Due possibly to this kindergarten experience, the results of the Arithmetic Readiness Test were very high. The mean score using ungrouped data, was 14.40 for the experimental groups, and 14.69 for the control groups. The scores ranged from 6 to 16 for the experimental groups, and from

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3. Guy T. Buswell, William A. Brownell, and Lenore John, Teachers' Manual to Accompany Jolly Numbers, Primer and Book One, Revised Edition, (Toronto: Ginn and Company), pp 134 - 136.

4. Ibid p.14

TABLE 7. Number of Children in Each Group Who Were Present for the Arithmetic Readiness Test, the Power Test in March, the Intelligence Test in May, and the Power Test in June.

Name of Group	Number present for Arithmetic Readiness Test	Number present for Power Test in March	Number present for Intelligence Test in May	Number present for Power Test in June	Number present for all 4 tests	Number dropped from the experiment.
Experimental #1	13	5	0	0	0	13
Experimental #2	29	27	26	26	26	3
Experimental #3	31	27	24	24	24	7
Experimental #4	27	23	22	22	22	5
Experimental #5	36	31	30	29	29	7
Experimental #6	33	28	27	26	26	7
Experimental #7	33	28	27	26	26	7
Experimental #8	27	21	20	20	20	7
Experimental #9	29	25	19	19	19	10
Experimental #10	30	19	18	18	18	2
Experimental #11	31	23	21	20	20	11
Total	309	257	234	230	230	79
Control #1	5	3	0	0	0	5
Control #2	22	20	16	14	14	8
Control #3	25	14	11	10	10	15
Control #4	27	24	22	22	22	5
Control #5	27	22	21	18	18	7
Control #6	33	31	29	29	29	4
Control #7	32	25	20	20	20	12
Control #8	27	24	17	17	17	10
Control #9	29	28	24	24	24	5
Control #10	31	27	23	22	22	9
Control #11	29	14	14	13	13	16
Total	285	232	197	189	189	96
Combined Totals of both groups	594	489	431	419	419	175

8 to 16 for the control groups. One hundred and six children in the experimental, and 100 children in the control groups had a perfect score of 16, indicating that the test was much too easy and was not a true measure of all the arithmetic knowledge possessed by these children. However, time did not permit the construction and validation of another Readiness Test.

CONSTRUCTION AND VALIDATION OF THE POWER TEST

OBJECTIVES OF THE POWER TEST. - The writer decided to administer a power test to all the children in the experimental and control groups early in March and to repeat the test near the end of June. The writer sought to obtain a standardized test which would measure the outcomes of elementary school arithmetic as set forth in the Forty-fifth Yearbook of the National Society for the Study of Education, The Measurement of Understanding; which are:

1. Computational skill
2. Mathematical understandings
3. Sensitiveness to number in social situations and the habit of using number effectively in such situations.[5]

SEARCH FOR A SUITABLE POWER TEST. - In an attempt to find such a test, the writer studied many test catalogues;

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5. Ben A. Sueltz et al, "The Measurement of Understanding in Elementary - School Mathematics", The Measurement of Understanding, Forty-fifth Yearbook of the National Society for the Study of Education, Part I, (Chicago: University of Chicago Press, 1946), p.140.

consulted the Child Guidance Clinic of Greater Winnipeg; purchased several specimen sets of tests; but none of the standardized tests was found by the writer to be appropriate for use at the Grade One level. Copies of Power Tests used in experiments similar to the experiment conducted by the writer were secured from the Board of School Trustees, Vancouver, B.C., The Saskatchewan Teachers' Federation, and the University of Edinburgh.

These tests were carefully analyzed, but none was considered suitable for the experiment reported in this thesis because in none of the reports accompanying the tests was the validity of the tests established. Accordingly the writer decided to construct and validate an original test to be used as the criterion of achievement.

CONSTRUCTION OF PRELIMINARY TEST NUMBER ONE. - (Appendix J). The first objective was to ensure that the Power Test had content validity, that is, that it conformed as closely as possible to the essential content of the prescribed course approved by the Minister of Education for the Province of Manitoba, and that it tested in a balanced way the essential knowledge and skills emphasized therein. The intent of the test was the measurement of understanding, meaning, insight and significance rather than of pure computation, speed and mechanical skill and would of necessity be rather weighted toward that end.

PART ONE. - Part One of Preliminary Test Number One was prepared on the basis of the topical outline for Grade One Arithmetic Grades I - VI[6]. This part of the test paralleled very closely the content of the course taught to the control groups.

PART TWO. - A second section was required to test whether the control or the experimental groups could better apply their mathematical skills when faced with novel or unfamiliar situations. This section would test concepts not included in either the authorized course or in the Cuisenaire course. The writer decided to select the items for this section from the Lazerte series Numbers Tell Their Story[7]. The reasons for this choice were threefold:

1. The Grade One programmes for eight series other than those being used by the experimental and control groups were analyzed. The Lazerte series Numbers Tell Their Story was found to contain the greatest number of concepts that would be novel to both groups of children taking part in the experiment.

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6. Arithmetic Grades I - VI, op. cit., pp 18 - 31.

7. M.E. Lazerte, Jean Dey, and Rose Svidal, Teachers' Manual for Numbers Tell Their Story Grade One, (Toronto: Clarke Irwin and Company Limited 1959).

2. The Lazerte method seemed to be a half-way measure between the Cuisenaire and the authorized method. It includes much manipulative material, not as much as the Cuisenaire method but a great deal more than the authorized method.
3. An experiment to test the effectiveness of the Lazerte method was being conducted in three Grade One classes in three Winnipeg schools concurrently with the experiment reported in this thesis. Although these were two distinct experiments, the same Power Test was to be used for both experiments.

The Grade One Lazerte course was summarized and twelve concepts novel to both the Cuisenaire and the authorized methods were selected. Part Two of Preliminary Test Number One was prepared, containing thirty-six items which measured these twelve novel concepts.

PART THREE. - Part Three of Preliminary Test Number One consisted of thirty representative items from the Cuisenaire handbook, Arithmetic With Numbers in Colour Introductory Stage Book I.[8]

Instructions for each item in Parts One, Two and Three were carefully prepared by the writer, (Appendix K)

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8. C. Gattegno, Arithmetic With Numbers in Colour Introductory Stage Book I, (London: William Heinemann, 1957).

These were to be given orally because the Grade One children had not yet developed the word attack skills necessary for such a reading task. Whenever possible, an example preceding each block of items, simple and obvious enough to be understood by the lowest mentality in the group was included in the test.

ADMINISTRATION OF PRELIMINARY TEST NUMBER ONE. - In January, 106 copies of Preliminary Test Number One consisting of 129 items were prepared. These were administered by the writer on January 25, 26, and 27 to 106 Grade One children in three Winnipeg schools in which there were no experimental or control groups.

So that the population to which the test was given might be a representative sample of the Grade One population of Winnipeg, the three schools were chosen from widely diverse areas of the city. In School A, situated in a low socio-economic area, the testees were the thirty-one children in the lower of the two Grade One classes. In School B, situated in an average socio-economic area, thirty-eight children were tested. The group in this case consisted of all the children in the upper Grade One class, plus the top group in the lower Grade One class. In School C situated in a very high socio-economic area, all the thirty-one pupils in the top Grade One class were tested.

The tests were administered in a uniform manner in each of the three schools. The directions for administering the test were carefully followed. No instructions other than those accompanying the test were given. In Part One and Part Two, the groups of items were not timed but when approximately 80% of the children had completed the group of items "without undue haste or unhealthful strain", the entire class moved on to the next group of items. As none of the children taking the test was familiar with the Cuisenaire materials, the 80% maxim was rescinded in Part Three of the test. When it was felt that the children had completed all they could do, time was called and the papers were collected. The classroom teachers were not present while the test was being administered.

When the testing had been completed, two papers from each group were drawn at random so that there would be exactly 100 papers on which to do an Item Analysis. These 100 test papers were scored by hand by the writer. An Item Analysis of Preliminary Test Number One (Appendix L) was prepared and the Index of Difficulty and the Index of Discrimination computed for each item. On the basis of the results of the Item Analysis, a second Preliminary Test was considered necessary.

REVISION OF PRELIMINARY TEST NUMBER ONE. - Since the Power Test was to be given to the control and experimental groups at the beginning of March and again toward the end of June, it was not considered necessary to delete any item because of a low Index of Difficulty. With the normal rate of maturation and learning common to the average six year old child, the items which showed a very low or zero Index of Difficulty in January, should have a much higher Index of Difficulty by the end of June. However, if the Index of Difficulty proved to be 90% or more, the items were considered too easy and were deleted.

In Part One of Preliminary Test Number One eighteen items had an Index of Difficulty of 90% or more and were deleted. (Table 8).

The Index of Discrimination showed all the items to which at least one correct answer was given to be GOOD except Items 2a and 5c which were already deleted because of their high rating on the Index of Difficulty, and Item 12f. Because there were only twelve correct answers in the top quartile, and twenty-one correct answers in the lowest quartile for this item, 12f was considered a BAD item and was therefore deleted.

CONSTRUCTION OF PRELIMINARY TEST NUMBER TWO.- Part One of Preliminary Test Number Two was prepared by revising Part One of Preliminary Test Number One in the following ways:

TABLE 8. Items on Preliminary Test #1 Having Index of Difficulty 90% or more

Item Number	Index of Difficulty
1a	96%
2a	96%
3a	97%
3b	92%
4a	93%
4b	97%
5c	99%
5e	93%
5f	95%
8a	91%
8b	90%
9f	95%
10b	90%
10c	90%
12a	90%
12c	95%
12d	93%
12g	92%

1. The eighteen items with Index of Difficulty 90% or more were deleted. This necessitated the deletion of two complete groups of items, Identification by Enumeration, and Reproduction.
2. The BAD item, 12f was deleted.
3. The groups of items were rearranged in order of difficulty, from easy to hard.
4. The individual items within the groups were re-arranged in order of difficulty, from easy to hard.
5. In Items 9a and 9b with Index of Difficulty 2% and 0%, it was not known whether the concept "Tell the Whole Story About", or whether the difficulty of the number combinations involved, caused the very low Index of Difficulty. In an attempt to find out where the difficulty lay, two easier stories were added, the stories 3,4 and 7, and 4,4 and 8. Item 9a was deleted and 9b was left intact.

In Part Two of Preliminary Test Number One, only three items 6a, 6b and 6c had an Index of Difficulty of 90% or more. These three items which tested the concept "One Half of an Object" were deleted from Preliminary Test Number Two. In addition, according to the Index of Difficulty, the groups of items were rearranged in order of difficulty, from easy to hard, and the individual items within the groups were rearranged in order of difficulty, from easy to hard. The Index of Discrimination showed all the items in Part Two to which at least one correct answer was given to be GOOD.

The thirty questions in Part Three of Preliminary Test Number One were so novel and unfamiliar to the 100 testees, and so few were answered correctly, that it was impossible to do any rearranging of the items in order of difficulty. This part of the test was left unchanged in Preliminary Test Number Two.

The Instructions were revised (Appendix M) and as with Preliminary Test Number One were to be given orally.

ADMINISTRATION OF PRELIMINARY TEST NUMBER TWO. - In February, 100 copies of Preliminary Test Number Two, (Appendix N) consisting of 106 items were prepared. These were administered by the writer on February 8, 9 and 10 to 100 children in three more Winnipeg schools in which there were no experimental nor control groups. As with Preliminary Test Number One, so that the population to which the test was given might be a representative sample of the Grade One population of Winnipeg, the three schools were chosen from widely diverse areas of the city. In School D, situated in a very low socio-economic area, the testees were the thirty-four pupils in the slowest of the three Grade One classes. Ten of these children were unable to follow the directions and do the examples preceding each block of items, so their test papers were discarded, leaving only twenty-four testees from School D. In School E, situated in an average socio-economic area, the forty-one testees included all the children in the upper Grade One classroom plus the two top groups in the lower Grade One classroom. In School F situated in a high socio-economic area, all thirty-five of the Grade One pupils in the school were tested.

The same procedures regarding administration of the tests, instructions, timing and scoring were observed as in Preliminary Test Number One, and the classroom teachers were not present during the testing.

An Item Analysis of Preliminary Test Number Two (Appendix O) was prepared and the Index of Difficulty and the Index of Discrimination computed for each item. The Item Analysis indicated several weaknesses in the test.

1. Item 5b Part One "Make another balloon <u>in front of</u> this balloon" proved to be a BAD item according to the Index of Discrimination. Nineteen testees in the lowest quartile had the answer correct and only four testees in the top quartile.
2. Items 1b and 6a Part One had an Index of Difficulty of over 90% but it was felt that there should be at least two easy items at the beginning of the test to motivate the children and that these should not be deleted.

REVISION OF PRELIMINARY TEST NUMBER TWO. -

1. Item 5b Part One was deleted.
2. The order of the blocks of items in Part One and Part Two was left unchanged, but where possible the items within the blocks were rearranged in order of difficulty from easy to hard.
3. Section B consisting of fourteen items was added to Part Two.
4. Part Three was left intact.

CONSTRUCTION OF THE POWER TEST. - It was thought that if the Power Test were to be truly valid, a further attempt should be made to ensure that the concepts it contained corresponded very closely with the concepts developed in current Grade One arithmetic programmes. With this in mind, the seven arithmetic series which the writer had previously analyzed were used.

1. Understanding Arithmetic, Grade One[9].
2. Exploring Arithmetic, I.[10]
3. Numbers We See, The Basic Mathematics Program.[11]
4. Making Sure of Arithmetic, Book One.[12]
5. Number Round-Up, I.[13]

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9. A.L. Sanders, et.al., op. cit.
10. H.T. Spitzer and M. Norman, op. cit.
11. A. Riess, M.L. Hartung, and C. Mahoney, op.cit.
12. R.L. Morton and M. Gray, op. cit.
13. K.E. Collins and R. Chivers, op. cit.

6. Arithmetic in My World, I.[14]

7. The Carpenter Clark Series.[15]

From these seven series, Section B consisting of fourteen items involving concepts not included in either of the preliminary tests, was added to Part Two of the Power Test.

By making these changes and additions to Preliminary Test Number Two, the Power Test (Appendix P) was constructed. Instructions to accompany the test (Appendix Q) were also prepared.

VALIDITY OF THE POWER TEST. - It was evident that since the Power Test was to be the sole criterion by which the relative achievement of the experimental and the control groups was to be measured this criterion must be a valid one. The validity of the test had to be established before it could be printed in final form and before it could be administered to the 594 children involved in the experiment. In order to establish the validity of the test the following list of questions was drawn up, each one requiring a positive answer before the test could be considered truly valid:

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14. C.N. Stokes, B. Adams, and M.B. Bauer, op.cit.

15. D. Carpenter and M.K. Clark, op. cit.

1. Does the test measure what it is intended to measure? Does it measure only what it is intended to measure?

   Yes. It measures computational skill, mathematical understandings, and sensitiveness to number in social situations. In Part One and in Part Three, reading ability is not a factor. In Part Two, however, there are nineteen questions involving reading ability. Since there is a total of 128 items on the test, nineteen items involving reading ability do not seem too great a number.

2. Does it have content validity, that is, does it test a sample of all the arithmetic a Grade One child is supposed to know?

   Yes. It tests every concept in the Topical Outline for Grade One, authorized by the Minister of Education for the Province of Manitoba,[16] as well as many other concepts above and beyond the minimum requirements.

3. Have others criticized it? In the judgment of competent persons, is it a good test?

   Yes. It has been analyzed and criticized by the Assistant Superintendent of Schools and by the five primary supervisors in the Winnipeg School Division No.1.

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16. Arithmetic Grades I - VI, op.cit.

4. Does it correspond with the concepts developed in other Grade One textbooks?

Yes. In addition to testing the concepts contained in the courses being studied by the experimental and control groups, it includes forty-six items novel to both the authorized course and the Cuisenaire method. These novel concepts are drawn from eight additional arithmetic series: Numbers Tell Their Story, Understanding Arithmetic, Arithmetic in My World, Making Sure of Arithmetic, Exploring Arithmetic, Number Round-Up, The Basic Mathematics Programme, The Carpenter-Clark Series.

5. Does it harmonize with the educational objectives outlined in the program of studies?

Yes. In the Program of Studies for Manitoba, it is stated that at the elementary level, arithmetic has the following specific objectives:

> 1. To develop clear understandings of the basic concepts and processes of arithmetic.
> 2. To develop competence in using the basic skills of arithmetic.
> 3. To develop competence in solving arithmetical problems.
> 4. To promote the development of logical thinking with quantitative data.
> 5. To develop ability to apply arithmetical information, concepts, principles, and skills to various social problems.
> 6. To promote desirable attitudes and appreciations with respect to the values of arithmetic.[17]

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17. Ibid., p.5.

The Power Test seems to test all these understandings except Number 6, it being almost impossible to measure attitudes and appreciations objectively.

6. Does it test what a Grade One child actually needs to know?

   Yes. In addition it goes far beyond what a Grade One child actually needs to know. The fact that it tests this additional information is felt by the writer to be the major weakness of the test.

7. Is it taller than any child in the group? Are there enough difficult items to challenge the brightest child in the group?

   Yes. The highest score on Preliminary Test Number One was 87 out of a possible 129 and on Preliminary Test Number Two, 65 out of a possible 106.

8. Does it discriminate between the good and the poor students?

   Yes. Any item which was "BAD" according to the Index of Discrimination on the preliminary tests was deleted.

9. Was the sample to whom the preliminary tests were given a representative sample of the Grade One population of Winnipeg?

   Yes. The 200 testees were from very low, low, average, high, and very high socio-economic backgrounds, and the classes ranged from the very slowest to accelerated Grade Ones.

10. Are the items arranged in order of difficulty from easy to hard?

Yes. The groups of items were rearranged, and the items within the groups were rearranged in this order after each preliminary test.

11. Is the wording in the instructions simple, clear and adequate?

Yes.

12. Is the test long enough to be valid?

Yes.

13. Is the scoring objective?

Yes, There is no question to which an alternate answer is plausible, and each correct item receives one mark.

14. Are the directions simple enough to be understood by the lowest mentality in the group?

No. When Preliminary Test Number Two was given to the slowest of the three Grade One classrooms in School D in a very low socio-economic area, ten children were unable to follow the directions and had to be excused from completing the test. The non-English background and the immaturity of these children, rather than the difficulty of the directions accompanying the test, were considered to be the reason for this lack of understanding.

15. Is the test free of any tricky or catch questions?

Yes. Two items which were considered "tricky" were deleted from the preliminary tests:

(a) Make another balloon <u>in front of</u> this balloon.

(b) Make another box <u>ahead</u> of this box.

16. Are there a few easy items at the beginning of the test to motivate the students?

Yes.

17. Is there a generous number of examples or fore questions given?

Yes. There is an example given in every case where this is feasible.

18. Is the test free of bias in favour of either group?

Yes. In Part I of the test, all the facts, concepts and principles tested should be familiar to all the children in both groups. Part II is intended to test facts, concepts and principles above and beyond those included in either the Cuisenaire or Living Arithmetic Series Grade One course. It is designed to test how well the children can apply their arithmetical knowledge in unfamiliar situations. Part III is intended only for the experimental groups. The scores for each part of the test are to be tabulated separately.

All the commonly used principles in the validation of test items were applied in the preparation of the Power Test. Courses of study, textbooks, and instructions procedures were carefully analysed. The items constituting the test were critically selected. An attempt was made to maintain a balance in the inclusion of facts, concepts and principles, their application and interpretation. The test seems to measure growth and achievement because the items included in it can not be answered by virtue of general intellect without knowledge of the subject matter concerned. In view of all these precautions it would seem permissible to assume that the Power Test would be a valid measure of achievement in arithmetic at the Grade One level.

FIRST ADMINISTRATION OF THE POWER TEST.- The Power Test was administered to the children in the experiment during the week of March 21 to March 25 by the six primary supervisors under reasonably standardized conditions. In each case the test was given immediately following the Opening Exercises in the morning. The instructions for administering the test had been carefully read by the supervisors beforehand, and were adhered to conscientiously. The same procedures regarding advance arrangements, seating, timing and scoring were observed as in the two Preliminary Tests. The classroom teachers were not present during the administration of the test, and neither they nor the principals of the schools concerned were shown the test since the same test was to be used again in June. To ensure uniformity all the tests were scored by the writer.

SECOND ADMINISTRATION OF THE POWER TEST.- The Power Test was administered for the second time during the week May 30 to June 3. The same procedures which had been followed during the first administration were observed. The primary supervisors administered the tests; the classroom teachers were not present during the test; and the tests were all scored by the writer.

The difference between a given pupil's score on the March test and his score on the same test given in June was taken as a measure of his gain in mathematical skill.

THE INTELLIGENCE TEST

In order to measure the mental ability of the children involved in the experiment, a suitable Intelligence Test had to be administered. It was decided to use the Kuhlmann-Anderson Test, Form B (Appendix R) for this purpose. The teachers in the experiment were provided with the necessary copies of the test and the manual of instructions for administering and scoring the tests,(Appendix S) well in advance of the date on which the tests were to be given. They were requested to aquaint themselves thoroughly with this information before attempting to administer the test.

The tests were administered by the classroom teachers immediately following the Opening Exercises on the mornings of May 25, 26 or 27. The teachers themselves scored the tests and tabulated the results.

THE QUESTIONNAIRES

In addition to the purely objective statistical results obtained from this study, the writer was interested in obtaining the subjective reactions of the ten teachers who had used the Cuisenaire method during the entire experiment, and also of the principals and vice-principals of the schools concerned, and of the primary supervisors who had witnessed children working with the materials on many occasions throughout the year. For this purpose two questionnaires based on the one designed by Drs. D. Karatzinas and T. Renshaw, Department of Education, University of Edinburgh,[19] were drawn up by the writer.

The first questionnaire (Appendix T) along with a letter of thanks for the cooperation displayed throughout the experiment and instructions regarding the answering of the questionnaire (Appendix U) was sent to the ten experimental teachers.

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19. D. Karatzinas and T. Renshaw, "Teachers' Views on the Cuisenaire Method", reprinted from <u>The Scottish Educational Journal,</u> (September 19 and 26, 1958), by the University of Edinburgh, Department of Education.

A slightly modified form of this questionnaire (Appendix V) along with a slightly different letter of thanks and set of instructions (Appendix W) was sent to the ten principals, the four vice-principals and the primary supervisors.

CHAPTER 4

TREATMENT OF DATA AND RESULTS OBSERVED

As previously stated, the purpose of the study undertaken by the writer was to secure some factual evidence regarding the relative achievement in arithmetic at the Grade One level, of pupils taught by the Cuisenaire method and those taught by the method outlined in the Living Arithmetic Series. The evidence obtained was of two kinds:

1. Objective data - the raw scores as recorded on the complete testing programme.
2. Subjective data - the reactions of all teachers and administrators involved in the experiment as recorded on the questionnaires.

The normality of the sample taking part in the experiment was established by applying the "Goodness of Fit" technique to the intelligence quotients obtained on the Kuhlmann-Anderson Intelligence Test.

Due to the design of the study, which precluded the use of more precise statistical analysis, only descriptive statistical techniques were employed to compare and contrast the behaviour of the experimental and control groups. Using ungrouped data, the writer computed, described and compared the mean, the standard deviation, and where applicable a frequency distribution and a histogram for each of the groups for each section of the testing programme.

OBJECTIVE RESULTS

THE NORMALITY OF THE DISTRIBUTION

Before it is possible to make any generalizations in regard to the behaviour of a group, it must be established that such a group is representative of the pupulation at large. With this in mind, the writer sought to determine whether or not the 230 children in the experimental groups and the 189 children in the control groups could be regarded as truly representative of the Grade One population of Winnipeg.

Although the best way to obtain a representative sample is to draw members at random from the population, random selection was not employed in the experiment reported in this study because the nature of the experiment precluded its use. However, the writer, in trying to assure that the children in the experiment would represent a cross-section of the population did select the children from all intellectual and socio-economic levels.

The Goodness of Fit technique recommended by Wert, Neidt, and Ahmann[1], was applied to the Intelligence Quotients

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1. James E. Wert, Charles O. Neidt, and J. Stanley Ahmann, Statistical Methods in Educational and Psychological Research, (New York: Appleton-Century-Crofts, Inc.) 1954, pp. 167 - 168.

obtained on the Kuhlmann-Anderson Intelligence Test. Chi square for the experimental groups (Table 9) was shown to be 9.39. Chi square for the control groups (Table 10) proved to be 7.19. When a table of Chi Square[2] was consulted, these differences were found to be well within the 5 per cent level of confidence. The evidence obtained by means of the Goodness of Fit technique was sufficient to indicate that the samples used in the experiment could be considered representative of the Grade One population of Winnipeg.

In addition to establishing the normality of the distribution, it was considered necessary to compare the differences between the children in the experimental groups and those in the control groups in respect to chronological age, intelligence, and arithmetic readiness.

CHRONOLOGICAL AGE

Both groups were similar in respect to chronological age. The mean chronological age of the experimental groups as at September 1, 1959 was 75.33 months, while that of the control groups was 75.37 months, a difference of .04 months in favour of the control groups.

THE KUHLMANN-ANDERSON INTELLIGENCE TEST

The combined scores of the 419 children in the experi-

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2. *Ibid*, p.423.

TABLE 9. Computation of Expected Frequencies and Goodness of Fit of Mean Scores on Kuhlmann-Anderson Intelligence Test -- Experimental Groups.

Interval	Observed Frequency	Lower Limit of Interval	x ($\bar{X}$=111.94)	x/σ Distance (σ=7.66)	Area	Expected Frequency (Area × N)	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
136-139	2)	135.5	23.56	3.08					
132-135	0)	131.5	19.56	2.55	.0655	15.065	5.065	25.654	1.70
	)=10								
128-131	1)	127.5	15.56	2.03					
124-127	7)	123.5	11.56	1.51					
120-123	22	119.5	7.56	.99	.0956	21.988	.012	.000	.00
116-119	43	115.5	3.56	.46	.1617	37.191	5.809	33.744	.90
112-115	56	111.5	- .44	- .06	.2011	46.253	9.747	95.004	2.05
108-111	33	107.5	-4.44	- .58	.1951	44.873	11.873	140.968	3.14
104-107	39	103.5	-8.44	-1.12	.1496	34.408	4.592	21.086	.61
100-103	14	99.5	-12.44	-1.62	.0788	18.124	4.124	17.007	.93
96-99	7)	95.5	-16.44	-2.15	.0368				
92-95	3) =13	91.5	-20.44	-2.67	.0120	12.098	.902	.814	.06
88-91	3)	87.5	-24.44	-3.19	.0025				9.39
	N= 230				.9987	230.000			

TABLE 10. Computation of Expected Frequencies and Goodness of Fit of Mean Scores on Kuhlmann-Anderson Intelligence Test -- Control Groups.

Interval	Observed Frequency	Lower Limit of Interval	x ($\bar{X}$=113.70)	x/σ Distance (σ=6.98)	Area	Expected Frequency (Area $\times$ N)	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
132 - 135	3)) 5	131.5	17.8	2.55	.0808	15.271	2.271	5.157	.33
128 - 131	2)	127.5	13.8	1.98					
124 - 127	8	123.5	9.8	1.40					
120 - 123	22	119.5	5.8	.83	.1225	23.152	1.152	1.327	.05
116 - 119	35	115.5	1.8	.26	.1941	36.684	1.684	2.836	.07
112 - 115	56	111.5	-2.2	- .32	.2281	43.110	12.890	166.152	3.85
108 - 111	34	107.5	-6.2	- .89	.1878	35.395	1.495	2.235	.06
104 - 107	14	103.5	-10.2	-1.46	.1146	21.659	7.659	58.660	2.70
100 - 103	10	99.5	-14.2	-2.03					
96 - 99	2))5	95.5	-18.2	-2.61	.0721	13.627	1.373	1.885	.13
92 - 95	3)	91.5	-22.2	-3.18					7.19
	N =189				1.0000	188.998			

mental and control group on the intelligence test formed an almost symmetrical curve. This is shown in the histogram in Figure A. There was a noticeable piling up of scores between 100 and 125. The over-all mean, (Table 11) using ungrouped data was 112.74.

As indicated in Figure B, the scores of the experimental groups formed a somewhat mesokurtic curve except for a piling up at 114. The scores of the control groups, (Figure C) formed an almost normal curve with a slight positive skewing, indicating that the test was rather easy for these groups.

From Table 11 it can be seen that with the exception of Group #4, in each case the mean score for the control group was higher than that of the matching experimental group. The differences ranged from .93 for Group #2 to 5.28 for Group #3. The mean score for the experimental groups was 111.94, and for the control groups 113.70, a difference of 1.76 points in favour of the control groups.

The mean standard deviation of 7.66 for the experimental and 6.98 for the control groups showed a somewhat greater spread in scores for the former than for the latter groups.

THE ARITHMETIC READINESS TEST

The scores on the arithmetic readiness test formed

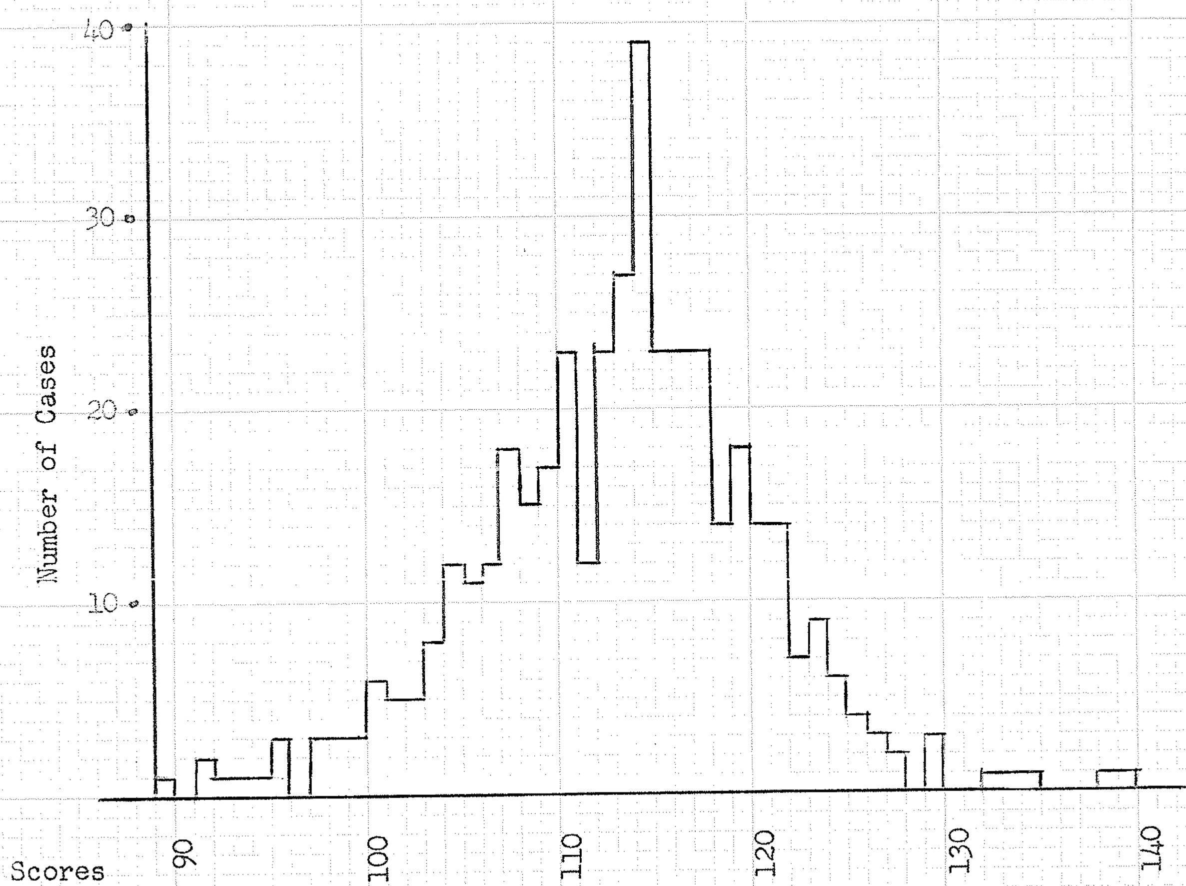

Fig. A. — Histogram of Scores on
Kuhlmann - Anderson Intelligence Test (419 cases).

TABLE 11. Mean Scores and Standard Deviation on the Arithmetic Readiness Test, Intelligence Test, Intelligence Test, and Power Test, Using Ungrouped Data.

Group Number: Experimental	Group Number: Control	Number of Pupils: Experimental	Number of Pupils: Control	Arithmetic Readiness Mean: Experimental	Arithmetic Readiness Mean: Control	Arithmetic Readiness Standard Deviation: Experimental	Arithmetic Readiness Standard Deviation: Control	Kuhlmann - Anderson Intelligence Quotient Mean: Experimental	Kuhlmann - Anderson Intelligence Quotient Mean: Control	Kuhlmann - Anderson Intelligence Quotient Standard Deviation: Experimental	Kuhlmann - Anderson Intelligence Quotient Standard Deviation: Control
2	2	26	14	14.538	15.429	1.45	.85	111.923	112.857	8.69	5.97
3	3	24	10	13.875	14.900	1.94	.88	108.125	113.400	8.53	3.57
4	4	22	22	14.773	14.455	1.38	1.57	114.045	108.500	5.81	8.20
5	5	29	18	13.828	14.778	1.97	1.35	113.966	116.556	5.85	4.27
6	6	26	29	15.692	14.931	.47	1.67	114.00	115.379	5.73	6.55
7	7	26	20	14.962	15.200	1.00	1.06	112.538	117.300	8.11	6.82
8	8	20	17	15.250	14.706	.79	1.31	113.200	114.529	6.67	6.28
9	9	19	24	13.632	14.333	1.57	1.40	110.579	112.042	9.85	6.66
10	10	18	22	13.000	14.045	2.25	1.99	112.333	115.818	8.62	7.69
11	11	20	13	14.050	14.385	1.85	1.85	107.550	108.846	6.31	5.01
Total Experimental / Control		230	189	14.404	14.688	1.70	1.50	111.943	113.704	7.66	6.98
Both		419		14.532				112.74			

TABLE 11. Continued

Group Number: Experimental	Group Number: Control	POWER TEST (MARCH) Part I Mean	Part I Standard Deviation	Part II Mean	Part II Standard Deviation	Part III Mean	Part III Standard Deviation
2		22.769	7.78	20.962	6.55	8.192	3.40
	2	33.071	2.40	26.929	4.36	2.500	1.22
3		22.042	7.78	22.750	6.10	5.208	3.57
	3	26.500	6.59	21.000	6.48	2.200	1.75
4		33.500	3.85	32.091	6.55	10.909	4.88
	4	30.273	5.38	25.545	4.65	4.091	2.35
5		30.827	5.61	25.276	7.73	8.862	6.22
	5	29.833	4.25	25.500	4.53	2.111	1.84
6		29.615	4.86	27.385	4.31	9.500	4.23
	6	28.310	4.54	25.759	5.81	1.172	1.42
7		27.846	7.36	27.269	7.07	10.115	6.45
	7	27.550	5.07	25.450	5.93	1.800	1.20
8		32.650	3.60	33.800	4.15	20.700	5.18
	8	29.117	4.12	25.647	4.42	.706	.92
9		25.158	3.22	21.105	5.81	13.000	4.56
	9	24.791	4.34	19.125	4.67	.292	.55
10		23.167	7.33	22.333	8.20	5.722	3.56
	10	23.136	6.72	19.864	6.37	.591	1.26
11		18.950	7.61	19.100	5.73	4.100	3.26
	11	28.462	6.36	23.923	5.22	1.462	1.51
Total Experimental		26.839	7.53	25.270	7.68	9.526	6.30
Control		27.894	5.62	23.847	5.86	1.619	1.82
Both				Parts I and II Mean			
				52.109			
				51.741			

TABLE 11. Continued

Group Number	POWER TEST (JUNE) Part I Mean	Part I Standard Deviation	Part II Mean	Part II Standard Deviation	Part III Mean	Part III Standard Deviation
2	28.692	4.80	27.769	5.76	10.500	6.55
2	34.071	3.20	30.714	4.03	4.000	1.84
3	27.417	5.84	30.167	6.89	8.333	5.98
3	29.400	6.15	26.100	5.09	3.300	2.11
4	37.091	3.91	39.364	3.79	21.636	5.91
4	29.364	4.54	29.455	4.49	2.773	1.97
5	35.862	3.82	35.172	6.02	16.552	6.41
5	33.889	3.31	30.667	4.61	1.556	1.76
6	33.269	5.10	36.385	4.21	17.038	5.17
6	30.621	3.88	30.828	5.94	3.724	2.22
7	30.885	5.40	34.077	7.68	15.423	7.50
7	31.750	4.88	34.800	5.70	3.350	2.01
8	37.150	4.04	39.150	3.30	26.800	3.09
8	32.471	3.95	32.235	3.51	3.353	2.18
9	29.263	5.12	32.632	5.38	14.632	5.90
9	30.417	4.54	25.875	4.76	1.375	1.06
10	28.778	7.36	29.944	9.78	11.111	6.47
10	27.727	6.53	26.364	5.11	2.773	1.54
11	28.900	5.85	25.700	7.09	10.550	6.75
11	33.077	5.53	28.231	7.14	3.923	2.56
Total Experimental	31.839	6.18	33.130	7.45	15.209	7.94
Control	31.069	4.99	29.614	5.73	2.937	2.08
Both			Parts I and II Mean			
			64.970			
			60.683			

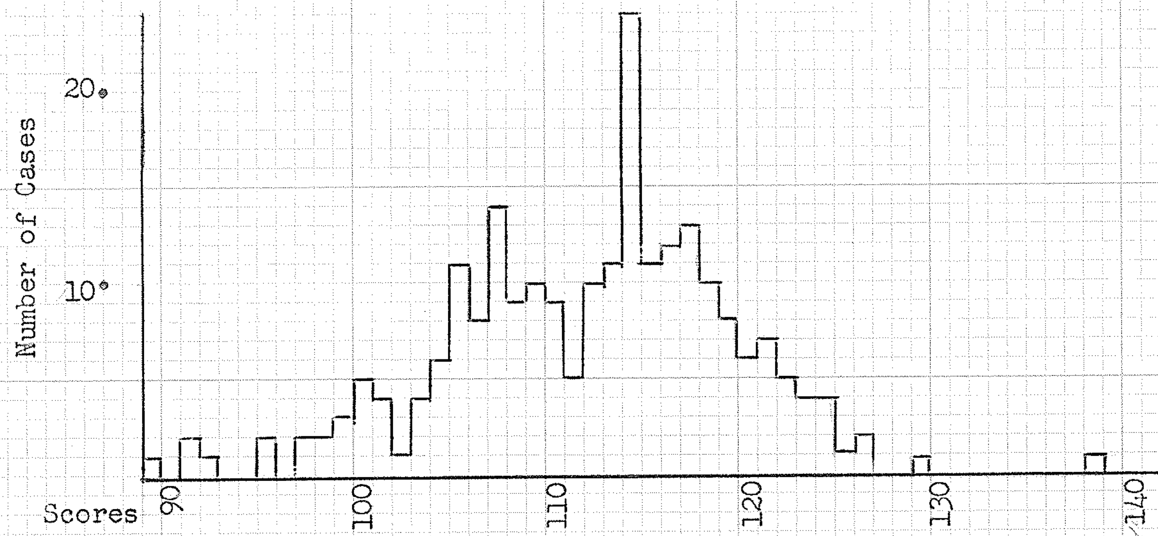

Fig. B. -- Histogram of Scores of
Experimental Groups on the Kuhlmann - Anderson Intelligence Test

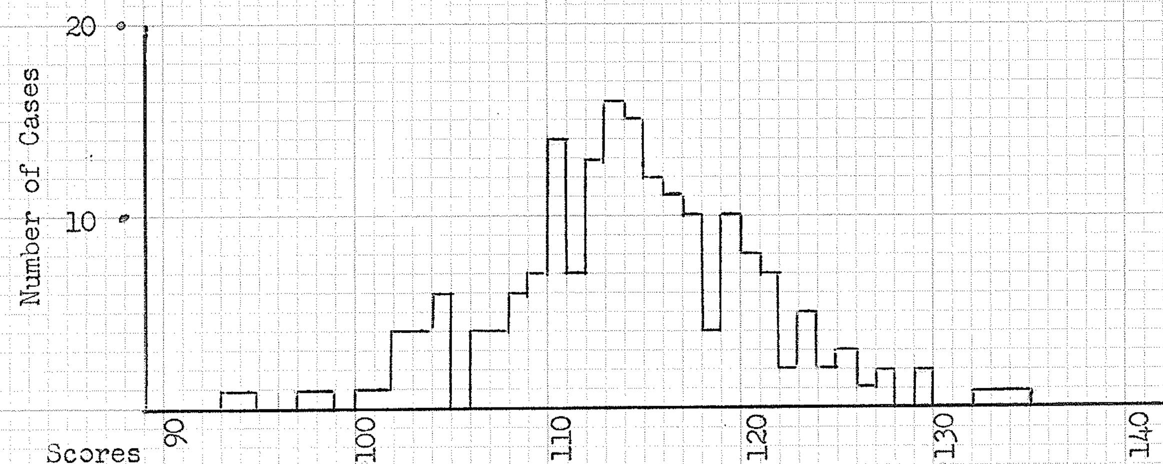

Fig. C. -- Histogram of Scores of
Control Groups on the Kuhlmann - Anderson Intelligence Test.

marked J curves (D, E, F,). These curves indicated that there was one factor with undue influence operating, in this case the low ceiling or easiness of the test. Of the 419 children taking the test, 147 had a perfect score of 16, and the lowest score was 9. (Table 12).

The histograms in Figures E and F indicate that the curves formed by the scores of the experimental and control groups were almost parallel, but that the performance of the control groups was superior to that of the experimental groups all along the line.

The mean of the control groups was 14.69 and of the experimental groups, 14.40, a difference of .28 in favour of the control groups. The standard deviation, (Table 11) indicated a tight grouping of the scores around the mean, the greatest spread being 2.25 in Experimental Group #10. The mean standard deviation was 1.70 for the experimental groups and 1.50 for the control groups.

In summary then, in chronological age, in intelligence, and in arithmetic readiness, the mean of the control groups was shown to be slightly higher than that of the experimental groups.

THE POWER TEST

Each of the three parts of the Power Test was scored separately, because each section was given for a different pur-

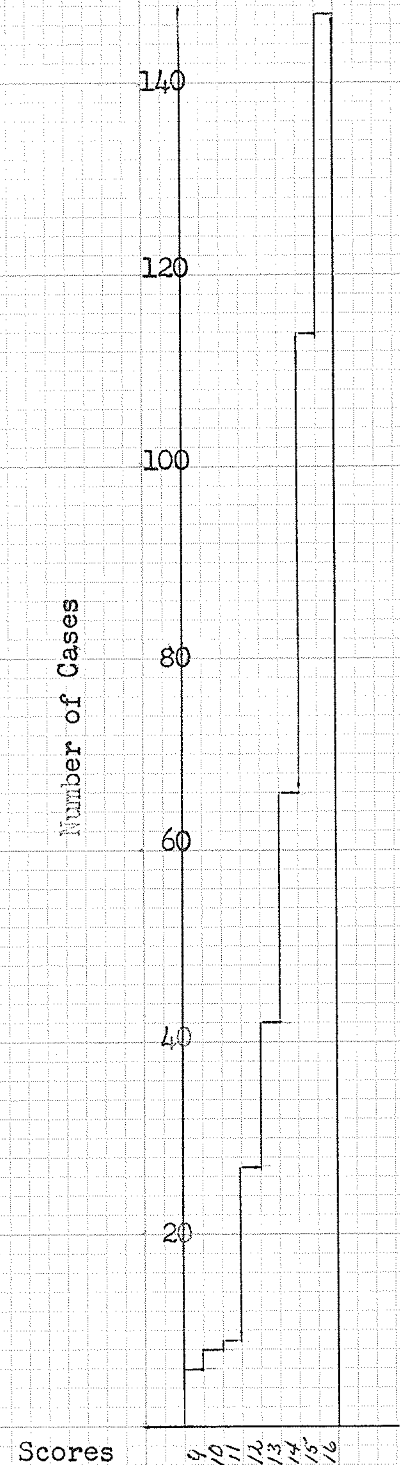

Fig. D.-- Histogram of Scores on Arithmetic Readiness Test (419 cases).

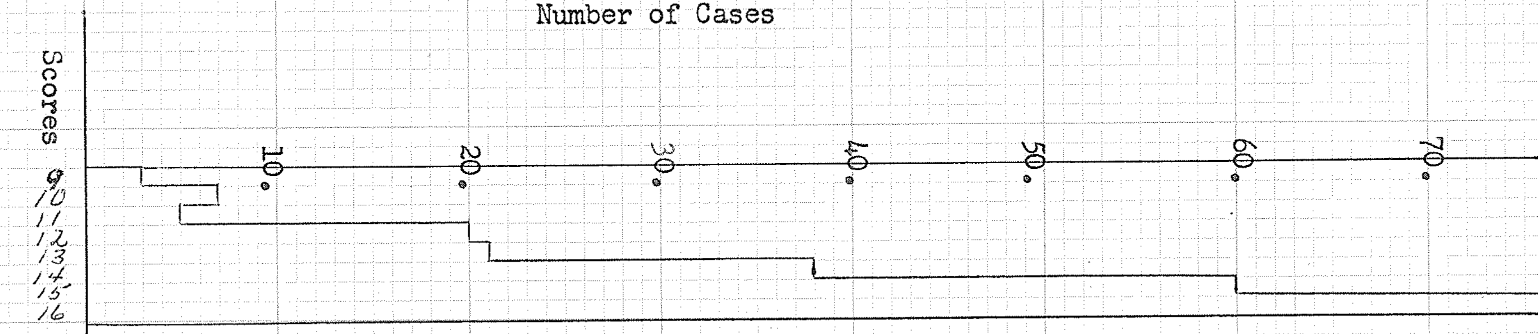

Fig.E. -- Histogram of Scores of
Experimental Groups on Arithmetic Readiness Test.

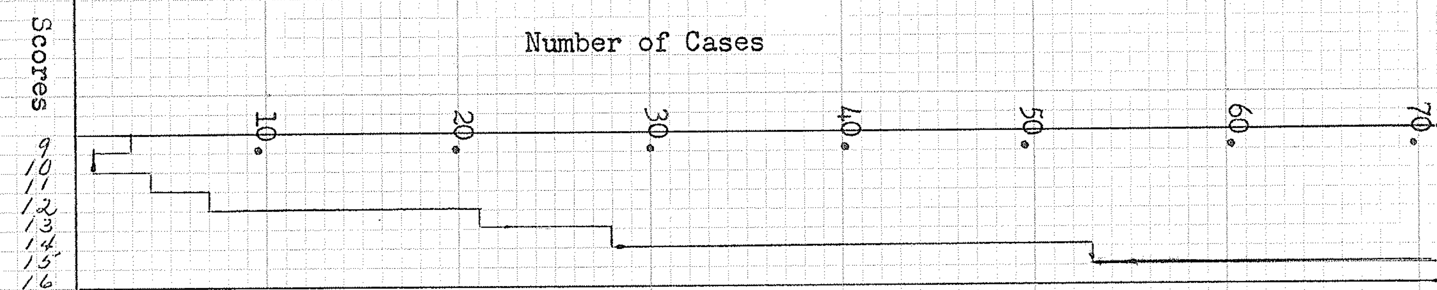

Fig.F. -- Histogram of Scores of
Control Groups on Arithmetic Readiness Test.

TABLE 12. Scores on Arithmetic Readiness Test.

Score.	16	15	14	13	12	11	10	9	Total
Name of Group	Number Correct								
Experimental									
#2	6	9	8	2				1	26
#3	7	3	5	3	3	1	2		24
#4	9	6	2	3	2				22
#5	7	5	7	4	2		4		29
#6	18	8							26
#7	9	9	7		1				26
#8	9	7	4						20
#9	3	4	2	3	7				19
#10	2	4	2	4	1	2	1	2	18
#11	6	5	1	2	4	2			20
Total	76	60	38	21	20	5	7	3	230
Control									
#2	9	2	3						14
#3	3	3	4						10
#4	8	4	4	3	2	1			22
#5	7	6		4	1				18
#6	13	12		1	1	1		1	29
#7	10	7		3					20
#8	6	5	2	3	1				17
#9	5	8	5	3	2	1			24
#10	7	2	7	3		1	1	1	22
#11	3	5	3	1				1	13
Total	71	54	28	21	7	4	1	3	189
Combined Total	147	114	66	42	27	9	8	6	419

pose. Part One was designed to test the children's ability to do the prescribed course of arithmetic as set out in the Programme of Studies for the Province of Manitoba. It contained 42 items. Part Two was designed to test the children's ability to apply their computational skills and mathematical understandings when faced with novel or unfamiliar situations, and tested concepts not included in either the authorized or the Cuisenaire course. It included 46 items. Part Three consisted of 30 representative items from the Cuisenaire course. These items tested ability to multiply, divide, and work out sums involving the use of fractions, - mathematical skills not required of children in Grade One following the traditional method and regular course.

Part One, March - The Histograms in Figures G and H show that in March the scores for both the experimental and control groups on Part One of the Power Test formed similar curves, both being somewhat negatively skewed with a piling up of scores at the high end. The mean score for the experimental groups, using ungrouped data, (Table 11) was 26.84 and 27.89 for the control groups, a difference of 1.05 in favour of the control groups. The scores of the experimental groups showed more spread than did those of the control groups, extending 2 points higher and 7 points lower. (Table 13). The mean standard deviation was 7.53 for the experimental and 5.62 for the control groups, indicating that the scores of

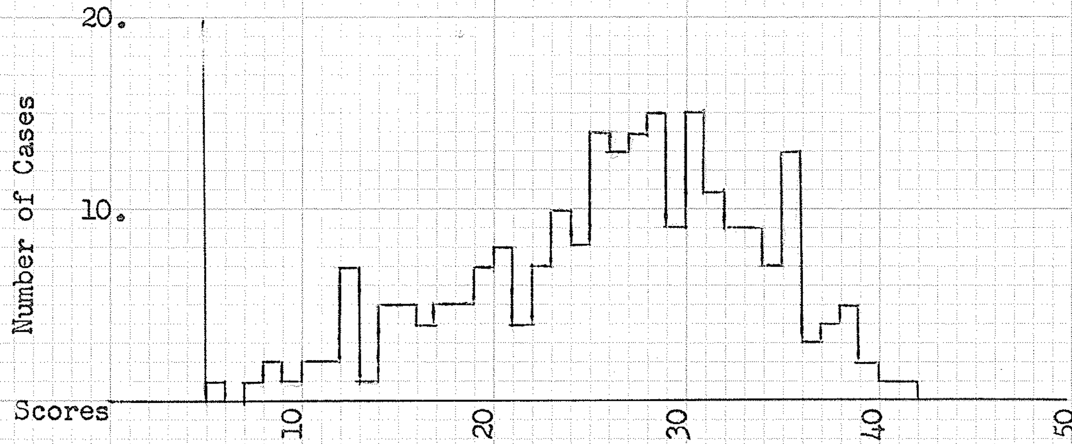

Fig. G. -- Histogram of Scores of Experimental Groups on Power Test, Part One, March.

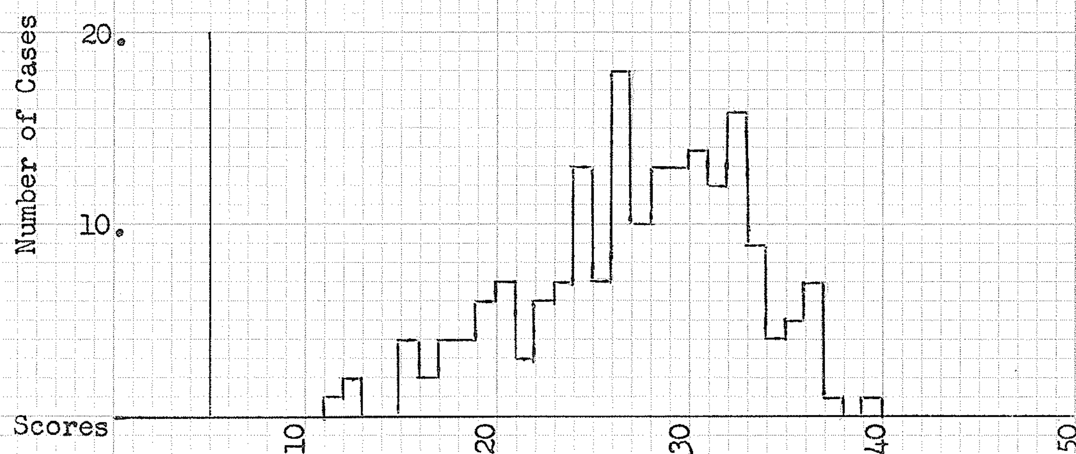

Fig. H. -- Histogram of Scores of Control Groups on Power Test, Part One, March.

TABLE 13. Scores on Power Test Part One. (March).

Scores	Group																					
	Experimental											Control										
	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
42				1							1											0
41			1								1											0
40			1	1							2			1								1
39			2		1	1	1				5											0
38				2	1	1					4										1	1
37	1	1				1					3	2	1	1		1		1			1	7
36			1	3	1	2	6				13			1	1		1			1	1	5
35			3	1	2		1				7	2		1	1							4
34			2	2	1	3	1				9	1	1	1	3	1		2				9
33	1		3		2	1	1		1		9	4		4	2	2	3				1	16
32	2		1	1	2	1	2		1	1	11	1		2	1	4			2	1	1	12
31		3	4	2	1		3	2			15	2	1	1	1	3	2	2		2		14
30		1	2	2	1	1				2	9	1	1	3	1		2	3	2			13
29	2	2		2	3	2	1	1	2		15	1	1	1	1	4	1	2	1	1		13
28			1	3	1	2	3	2	1	1	14			1		4	1	1	2	1		10
27	2	2		1	2			2	3	1	13				1	4	2	4	3	2	2	18
26	2	1	1	3	2	2	1	1	1		14				2		2	1	1		1	7
25	2	1			1	1		2	1		8			1	1	1	3		3	1	3	13
24		1		2	3	1		1	2		10		1		3	1				2		7
23	1			1	1			3		1	7						1		2	2	1	6
22				1				3			4		1	2								3
21				1	1	2		2		2	8		1	1					3	2		7

TABLE 13. Continued

	Group																						
	Experimental											Control											
Score	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	
20	4	2								1	7			1		2			2	1		6	
19	2					1			2		5		1			2			1			4	
18		1				1			1	2	5		1					1	2			4	
17	1	2								1	4						1			1		2	
16	1					2				2	5						1			2	1	4	
15	2	2				1					5											0	
14	1										1											0	
13	2	3								2	7									2		2	
12		1							1		2									1		1	
11										2	2											0	
10									1		1											0	
9		1								1	2											0	
8									1		1											0	
7											0											0	
6											0											0	
5										1	1											0	
	26	24	22	29	26	26	20	19	18	20	230	14	10	22	18	29	20	17	24	22	13	189	419

the control groups were more closely grouped around the mean than were those of the experimental groups.

Part Two, March. - On Part Two of the test, the section in which the children were required to apply their arithmetic knowledge in new or unfamiliar situations, the experimental groups were slightly ahead of the control groups in March. The mean score on this section of the test, (Table 11) was 25.27 for the experimental and 23.85 for the control groups, a difference of 1.42 in favour of the experimental groups. The histograms in Figures I and J indicate that the experimental groups had many more scores at the high end of the curve than did the control groups, but also several more at the low end. The mean standard deviation was 7.68 for the experimental and 5.86 for the control groups, indicating that as in Part One, the scores of the control groups were more closely grouped around the mean than were those of the experimental groups.

Part One and Part Two, March. - When the scores for Part One and Part Two were totalled, the spread was even more evident, as shown in the histograms in Figures K and L. While the curves in both cases were somewhat platykurtic, the scores for the experimental groups spread out further at both ends, especially at the high end, than did those of the control groups. This can be seen also in the frequency distribution in Table 14. The highest score made by a member of the control groups was 73

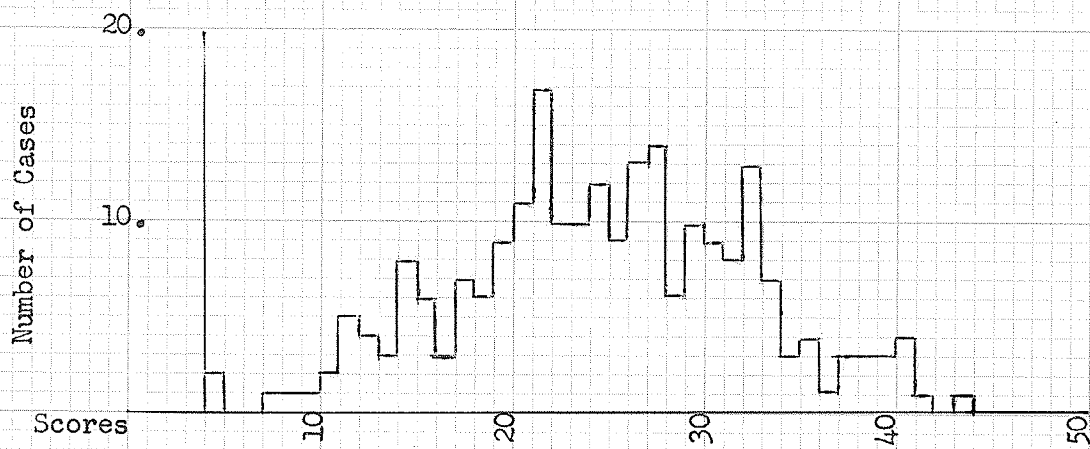

Fig. I. -- Histogram of Scores of
Experimental Groups on Power Test, Part Two, March.

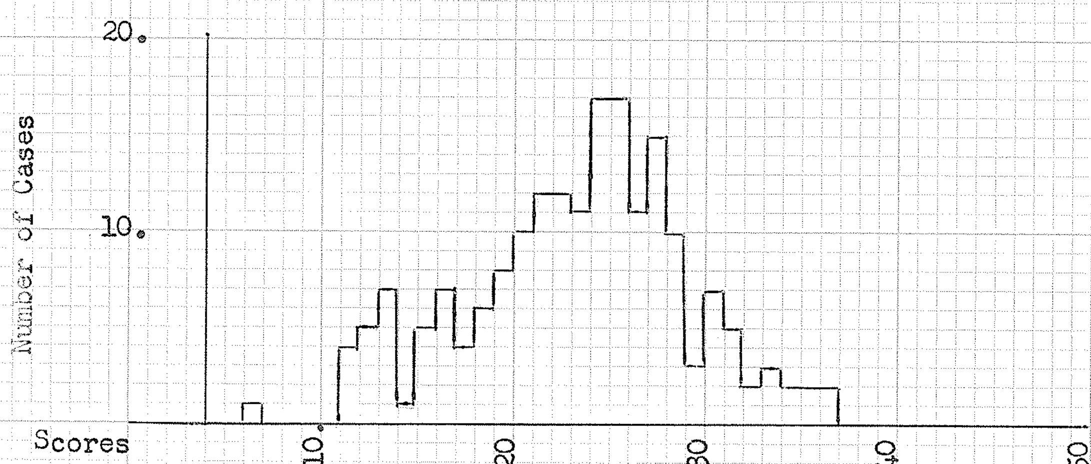

Fig. J. -- Histogram of Scores of
Control Groups on Power Test, Part Two, March

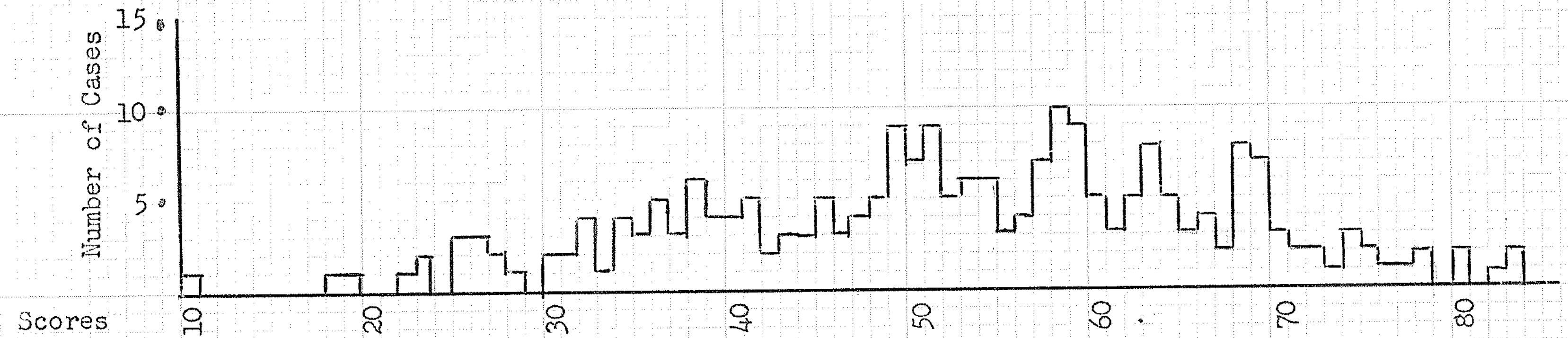

Fig. K. -- Histogram of Scores of Experimental Groups on Parts One and Two of Power Test, March.

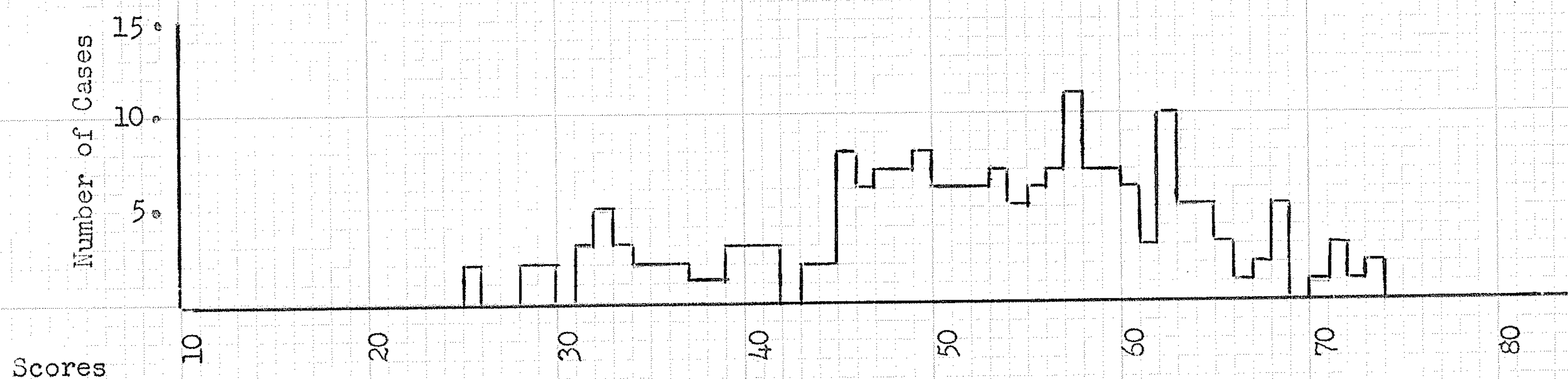

Fig. L. -- Histogram of Scores of Control Groups on Parts One and Two of Power Test, March.

TABLE 14. Scores on Power Test. Part One and Part Two (March)

Score	Group																					
	Experimental											Control										
	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
83			1	1							2											0
82			1								1											0
81											0											0
80			1			1					2											0
79											0											0
78			1			1					2											0
77					1						1											0
76							1				1											0
75			1				1				2											0
74			1	1			1				3											0
73					1						1					1		1				2
72	1			1							2			1								1
71				1			1				2		1	1	1							3
70				1			2				3										1	1
69				1		2	4				7											0
68			1	1	1	2	3				8	1				1	1	1			1	5
67		1				1					2	1		1								2
66			2	1		1					4		1									1
65			1	1			1				3	1			1	1						3
64			2	1	1	1					5	2			1	1				1		5
63		1	1		4		1			1	8			1	2	1	1					5
62			1		1	1	1		1		5	1		1		4	2	1			1	10
61				1	1			1			3			1			1				1	3

TABLE 14. Continued

Score	Group																					
	Experimental										Total	Control										Total
	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11		#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	
60	1	1	2			1					5	1		3			1			1		6
59	1	2	2	1		1			1	1	9				1	1	3	1		1		7
58		1		3	2		2		2		10	4		2		1						7
57		1	1		2	1	1		1		7				3	2		3	2	1		11
56	1				1			1	1		4	1		1			1	3		1		7
55	1		2								3			1	1	1	1		1	1		6
54				1	3	1			1		6			3	1	1						5
53	2	1		1				1	1		6	1				3		2			1	7
52	1	1		1				1		1	5			1	1	1		2			1	6
51				1	2			3	1	2	9		1				1	1	1	2		6
50	2					1	1	3			7				1	1	1		2		1	6
49	1	1		2		4			1		9	1	2	1					3		1	8
48	1		1		1	1			1		5				2	1	1	1	2			7
47		1			1			2			4					2	1		1	1	2	7
46		1		1	1						3			1			1		2	1	1	6
45	1	1			2				1		5				2	3	2				1	8
44		1			1					1	3					1				1		2
43	1			1		1					3			1	1							2
42	1			1							2											0
41				1		1		1	1	1	5			1					1	1		3
40				1				2		1	4		1						1	1		3
39				1				1		2	4		2						1			3
38	2	1		1		1			1		6								1			1
37	3										3									1		1

TABLE 14. Continued

Score	Experimental #2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	Control #2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
36		3				1		1			5		1							1		2
35	1							1		1	3		1						1			2
34		1		1					1	1	4								1	1		2
33		1									1					1	1		1			3
32	2					1				1	4			1		1			2	1		5
31	1									1	2						1	1			1	3
30		1						1			2											0
29											0									2		2
28						1					1								1	1		2
27									1	1	2											0
26		1								2	3											0
25	1	1								1	3									2		2
24											0											0
23										2	2											0
22		1									1											0
21											0											0
20											0											0
19									1		1											0
18	1										1											0
10									1		1											0
	26	24	22	29	26	26	20	19	18	20	230	14	10	22	18	29	20	17	24	22	13	189

out of a possible 88, while 15 members of the experimental groups made this score or higher. Only 2 children in the control groups scored less than 28, compared to 14 children in the experimental groups. The over-all mean score on Parts One and Two of the test in March, using ungrouped data, was 52.11 for the experimental groups and 51.74 for the control groups, a difference of .37 in favour of the experimental groups.

Part Three, March. - Part Three of the test, was intended for those children who had been taught by the Cuisenaire method, and was much too difficult for the control groups. The frequency distribution in Table 15 indicates that only 5 of the 189 children in the control groups scored more than 5 out of a possible 30, and that 70 of them scored zero. The mean score for the control groups, (Table 11) was 1.62 compared to 9.53 for the experimental groups, a difference of 7.91 in favour of the experimental groups. The mean standard deviation, (Table 11) was 6.30 for the experimental and 1.82 for the control groups, indicating a wide spread in scores for the experimental, and a great clustering around the mean for the control groups. The experimental groups, then, had made slightly higher scores on the total of Parts One and Two of the Power Test in March, and in addition had made considerable progress in learning how to multiply, to divide, and to work out sums involving the use of fractions.

Part One, June.- When the test was given again in June,

TABLE 15. Scores on Power Test, Part Three (March)

Score	Group																					
	Experimental											Control										
	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
27							2				2											0
26							1				1											0
25				1		1	4				6											0
24							1				1											0
23						1					1											0
22							2	1			3											0
21											0											0
20				1			3	1			5											0
19			2	2		1	3				8											0
18	1		2				1	1			5											0
17							1	3			4											0
16			1		1	3					5											0
15				1	1						2											0
14	1		2	1	1	2		2	1		10											0
13	1		1	1	6	2		1			12											0
12		2	1	1	3	1		3			11											0
11	2		1	1	1			1		1	7			1								1
10	2	2	2		2			1	1		10											0
9	3	1	2	4	1	1	1	2	3		18											0
8	5	2	1	2	1	4			1	1	17			1								1
7	3	2	3	2	1	1		2		1	15			1								1
6	3		1	4	2	2		1		5	18			1	1							2

TABLE 15. Continued

Score	Experimental #2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	Control #2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
5	2	3	1	1	2	1	1		7	1	19		1	2	1	1				1		6
4	1	2	2	1	1	3				2	12	3	2	8	3	1	2				2	21
3	2	2		2	1	1			3	2	13	5	1	2	1	4	4	1		1	1	20
2		6		1	2					3	12	3	2	4	4	3	4	2	1	1	3	27
1		1		2		2				1	6	2	2	2	4	7	8	5	5	3	2	40
0		1		1					2	3	7	1	2		4	13	2	9	18	16	5	70
	26	24	22	29	26	26	20	19	18	20	230	14	10	22	18	29	20	17	24	22	13	189

the scores on Part One formed curves similar to those formed by the scores on the same part of the test in March. The histograms in Figures O and P show that the curves for both the experimental and the control groups were negatively skewed, with a greater piling up of both sets of scores at the high end than had been the case in March, and with the piling up much more noticeable in the case of the experimental than in the case of the control scores. The mean score for the experimental groups, using ungrouped data, (Table 11) was 31.84 and 31.07 for the control groups. This was a difference of .77 in favour of the experimental groups, whereas in March the difference on this part of the test was 1.05 in favour of the control groups. The experimental groups, then, had not only caught up to the control groups in ability to work

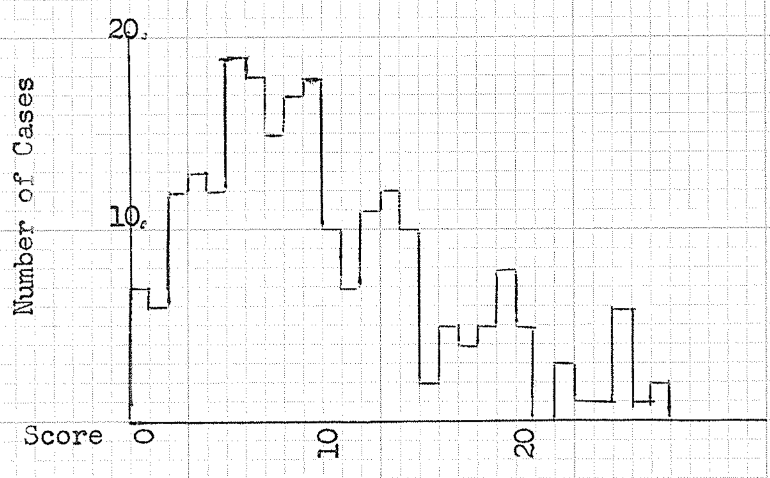

Fig. M. -- Histogram of Scores of Experimental Groups on Power Test, Part Three, March.

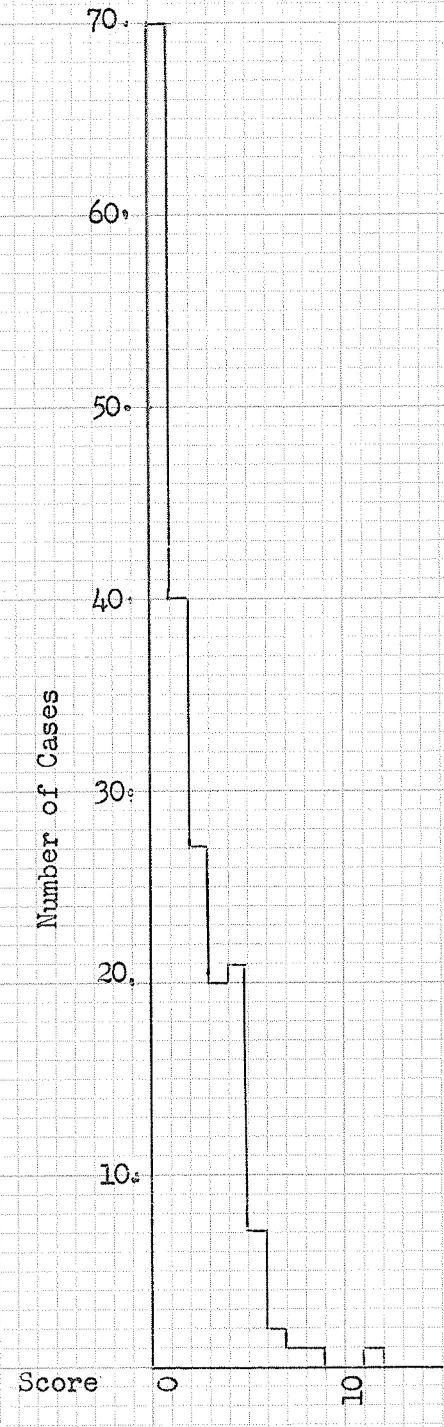

Fig. N. -- Histogram of Scores of Control Groups on Power Test, Part Three, March.

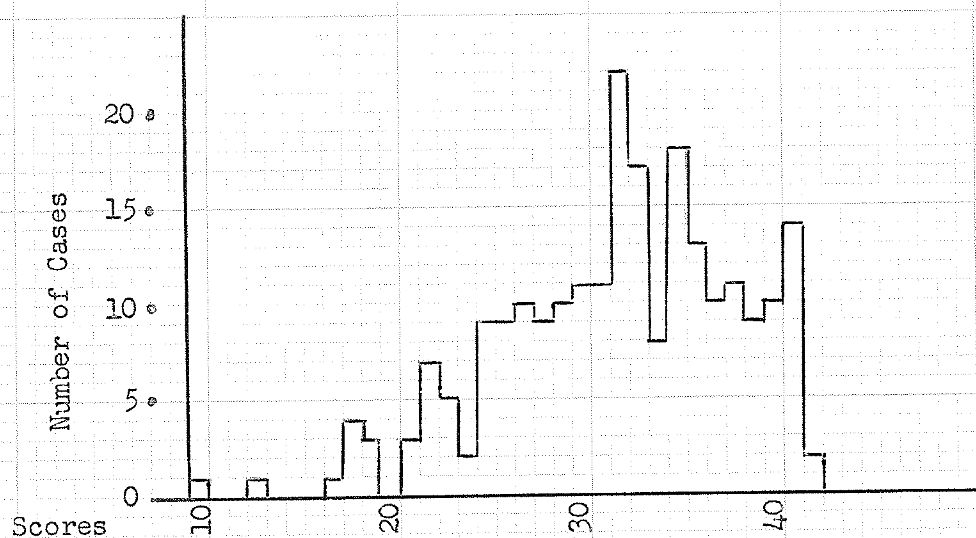

Fig. O. — Histogram of Scores of Experimental Groups on Power Test, Part One, June.

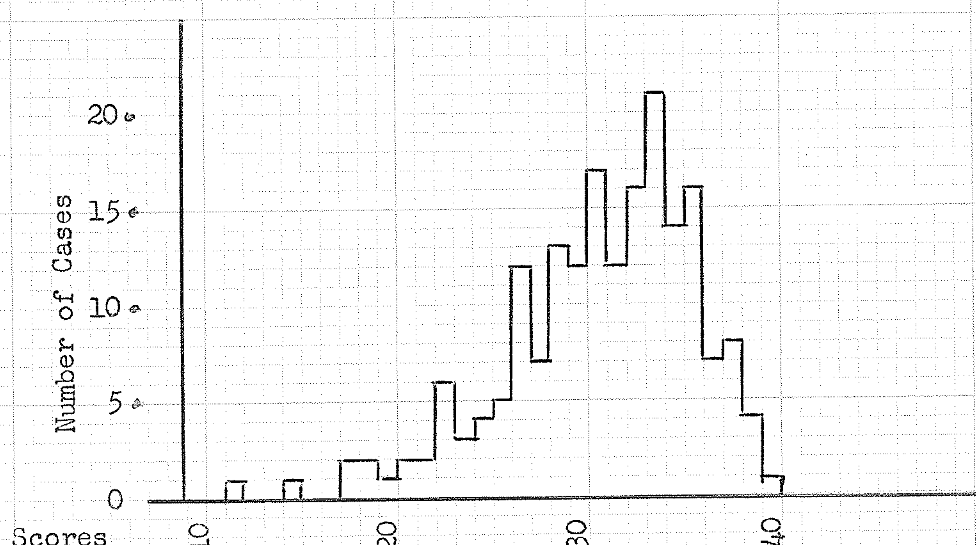

Fig. P. — Histogram of Scores of Control Groups on Power Test, Part One, June.

out the 42 questions based on the prescribed course in arithmetic as authorized by the Minister of Education for the Province of Manitoba, but by June had surpassed them by a mean score of .77

The mean standard deviation was 6.18 for the experimental and 4.99 for the control groups, indicating that as in March the scores of the experimental groups were more spread out than were those of the control groups.

Part Two, June. - On Part Two of the test in June, the scores of the experimental groups were more noticeably higher than those of the control groups than they had been in March. This can be seen by comparing the histograms in Figures Q and R with those in Figures I and J. In June, the scores of the control groups formed a somewhat normal curve, while those of the experimental groups formed a curve that was negatively skewed, with a piling up of scores at the high end. In June, the mean score for the experimental groups on Part Two, using ungrouped data (Table 11) was 33.13 and 29.61 for the control groups. This was a mean difference of 4.52 in favour of the experimental groups, as compared to a difference of 1.42 in their favour in March. This difference of 4.52 on Part Two of the test, indicated that by June, the children taught by the Cuisenaire method were better able to apply their mathematical understandings when faced with novel or unfamiliar situations than were the children taught by the traditional method.

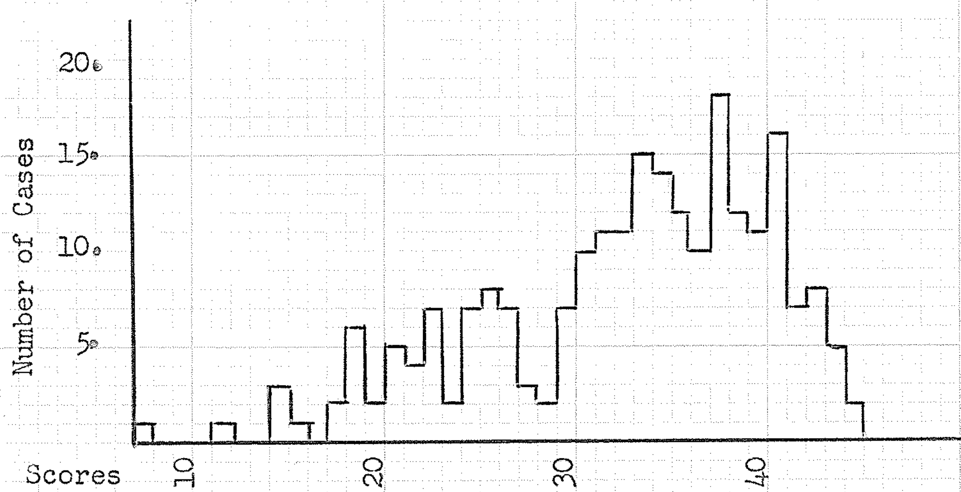

Fig. Q. -- Histogram of Scores of Experimental Groups on Power Test, Part Two, June.

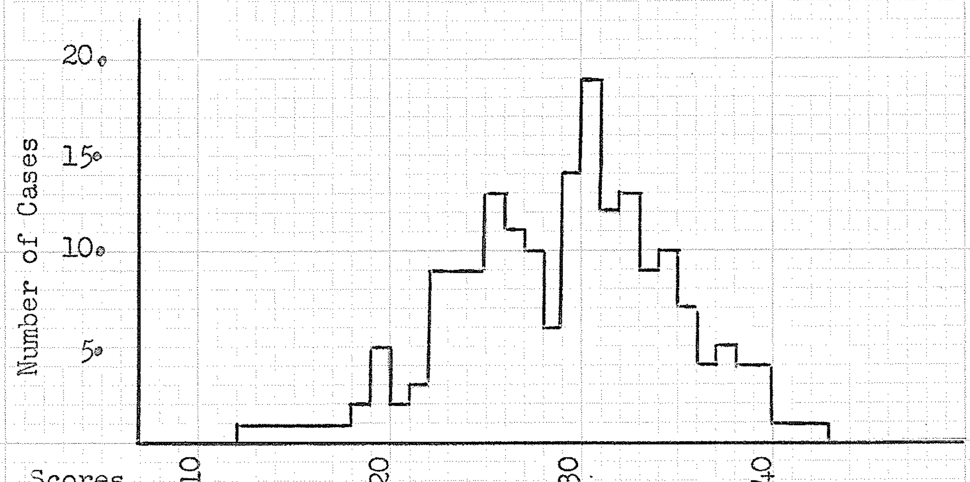

Fig. R.-- Histogram of Scores of Control Groups on Power Test, Part Two, June.

Part One and Part Two, June. - When the June scores for Part One and Part Two were totalled, the piling up of scores at the high end was much more evident in the case of the experimental than in the case of the control groups. This is shown in Figures S and T. Both curves were somewhat platykurtic, but that of the experimental groups was much more negatively skewed than was that of the control groups. From the frequency distribution in Table 16 it can be seen that in June, 35 children in the experimental groups had scores of 78 or more out of a possible 88, while only 4 children in the control groups scored 78 or higher. At the lower end of the scale, 11 children in the experimental groups scored 40 or less as compared with 8 children in the control groups.

In June the over-all mean score on Part One and Part Two of the test was 64.97 for the experimental groups and 60.68 for the control groups, a difference of 4.29 in favour of the experimental groups. This difference was considerably greater than in March, when the mean score of the experimental groups had been only .37 greater than that of the control groups on these two sections of the test. This increased difference indicated that while the experimental groups had not outdistanced the control groups by any great amount from September to March, they had made considerable advances from March to June.

Part Three, June. - In addition to their superior per-

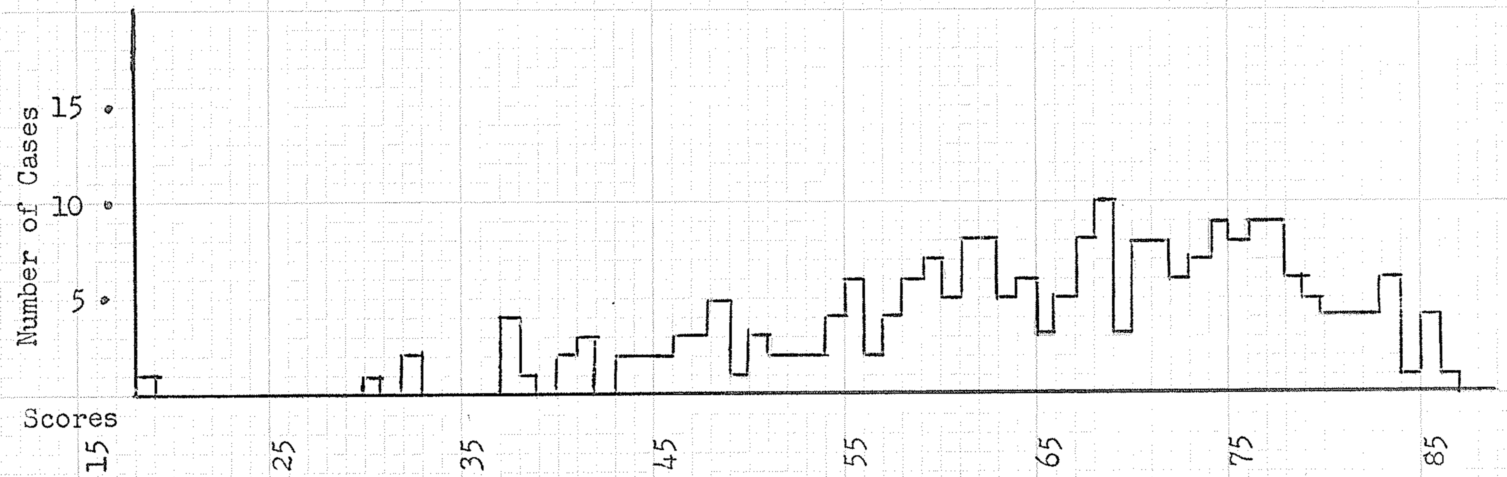

Fig. S. -- Histogram of Scores of
Experimental Groups on Parts One and Two of Power Test, June.

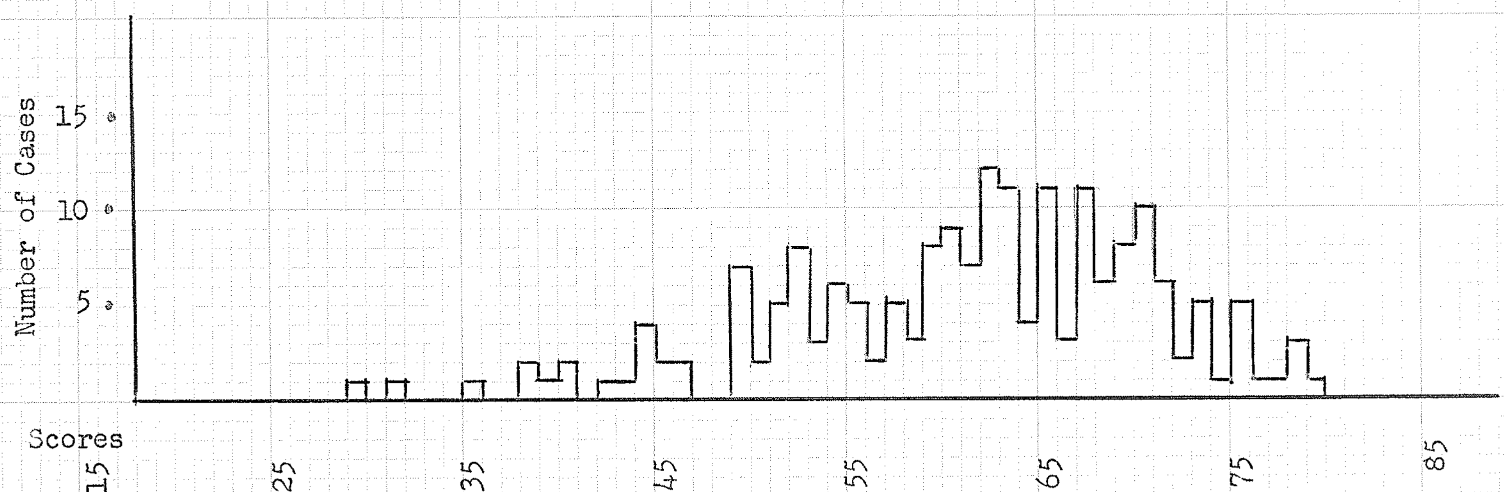

Fig. T. -- Histogram of Scores of
Control Groups on Parts One and Two of Power Test, June.

TABLE 16. Scores on Power Test, Part One and Part Two, (June)

	Groups																					
	Experimental											Control										
Score	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
86							1				1											0
85			1	3							4											0
84			1								1											0
83			2	1	1	1	1				6											0
82			2	1			1				4											0
81			2				2				4											0
80		1			2		1				4											0
79			1	2	1		1				5						1					1
78	1		2			1	2				6					1	2					3
77			3	1		2	3				9						1					1
76			1	1	4		2		1		9	1										1
75		1		2		2	1		1	1	8				1	1	2	1				5
74		1	1	3		2	1	1			9				1							1
73		1	1		2		1		1	1	7				1	1	2	1				5
72				2	2		1		1		6	1				1						2
71		1	1		2	2			2		8		1		1	2					2	6
70	2				1	1		3	1		8	1		1		1	1	3		2	1	10
69			1	1	1						3	2			1	2	2		1			8
68		2		3	2	1		1	1		10			2	1			1	1		1	6
67	1		1	1	1	1		3			8	1	1	1	1		1	2		1	3	11
66			1			2		1		1	5		1					1		1		3
65	1					1			1		3	2	1	1		3		1	1	1	1	11

TABLE 16. Continued

Score	Groups																					
	Experimental										Total	Control										Total
	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11		#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	
64								1	2	3	6			1	1				1		1	4
63	1				1	1	1	1			5			1	2	2	2	2	2			11
62	1	2		1	1	1		2			8			2	4		1		1	3	1	12
61	1	1		1	3			1		1	8	2			1	1		1	1	1		7
60	1			2						2	5	2		1		2	1	1	2			9
59	3	2	1					1			7			5		1			2			8
58				2		3	1				6			1	1			1				3
57	1			1						2	4	1		1		1			2			5
56				1		1					2			1						1		2
55	1	2				2		1			6	1			1	1			1	1		5
54	2									2	4					4		1	1			6
53		1			1						2				1	2						3
52	1	1									2		1	1		1			2	2	1	8
51		1						1			2		2				1		2			5
50	1				1				1		3						2					2
49									1		1		1				1	1	1	3		7
48	3	1						1			5											0
47	2	1									3											0
46	1								2		3								1	1		2
45									1	1	2		1						1			2
44		2									2			2		1				1		4
43		1								1	2					1						1
42											0										1	1

TABLE 16. Continued

	Groups																					
	Experimental											Control										
Score	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
41	1	1								1	3											0
40										2	2									2		2
39											0			1								1
38	1										1		1							1		2
37		1				1				2	4											0
36											0											0
35											0									1		1
34											0											0
33											0											0
32								1	1		2											0
31											0										1	1
30						1					1											0
29											0								1			1
18									1		1											0
	26	24	22	29	26	26	20	19	18	20	230	14	10	22	18	29	20	17	24	22	13	189

formance on Part Two of the test, the experimental groups achieved significant results on the June administration of Part Three of the test. The mean score for the experimental groups on this part of the test, using ungrouped data (Table 11) was 15.21 out of a possible 30 in June, compared to a mean formance on Part Two of the test, the experimental groups achieved significant results on the June administration of Part Three of the test. The mean score for the experimental groups on this part of the test, using ungrouped data, (Table 11) was 15.21 out of a possible 30 in June, compared to a mean score of 9.53 in March, while for the control groups it was 2.94 in June compared to 1.62 in March. The difference in the mean scores on Part Three in June was 12.27 in favour of the experimental groups. The mean standard deviation (Table 11) was 7.94 for the experimental and 2.08 for the control groups, indicating a considerable spread in the scores of the experimental groups, and an intense clustering around the mean for the control groups. This can be seen in the histograms in Figures U and V.

Thus, by June, in addition to their superior performance on Part Three of the test, the experimental groups had caught up to the control groups in ability to do the work of the prescribed course in arithmetic, and had outdistanced the control groups in ability to apply their computational skills and mathematical understandings in novel or unfamiliar situations as assessed in Part Two of the Test.

Gains on Part One and Two.- From Table 17 and Figures W and X it can be seen that the experimental groups made higher gains on Parts One and Two of the Power Test from March to June than did the control groups. The histogram showing the gains made by the control groups (Figure W) forms almost a normal curve, while that of the experimental groups (Figure X) is negatively skewed and definitely weighted toward the higher end. The highest

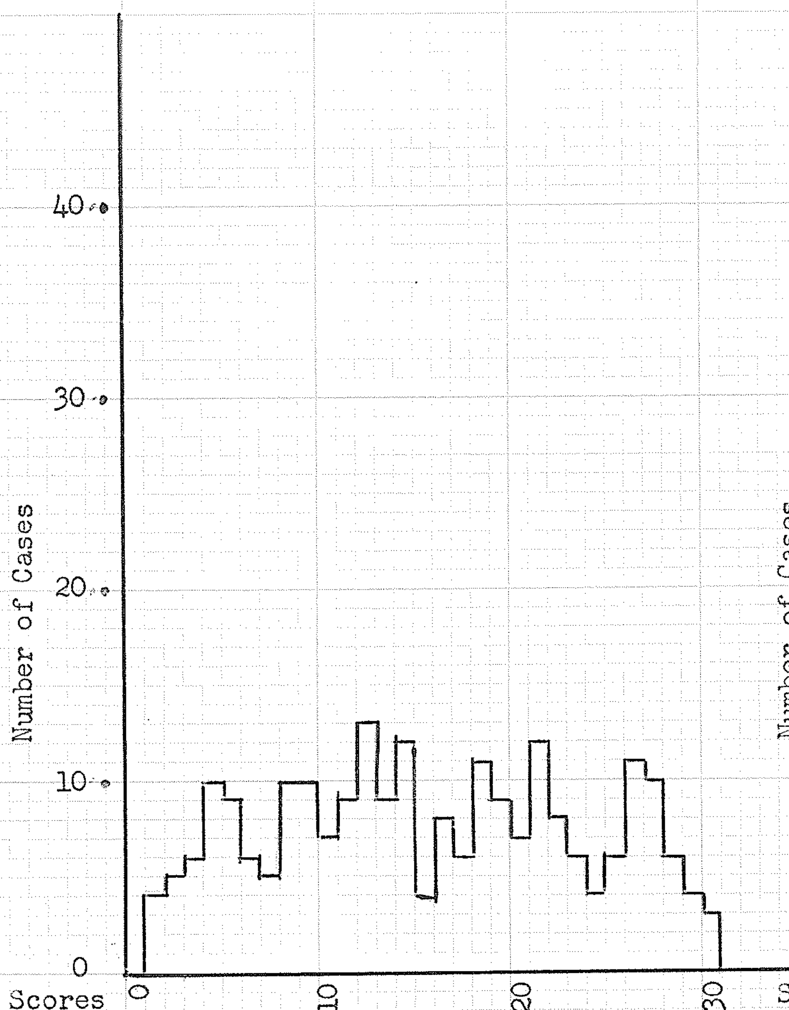

Fig. U. — Histogram of Scores of Experimental Groups on Power Test, Part Three, June.

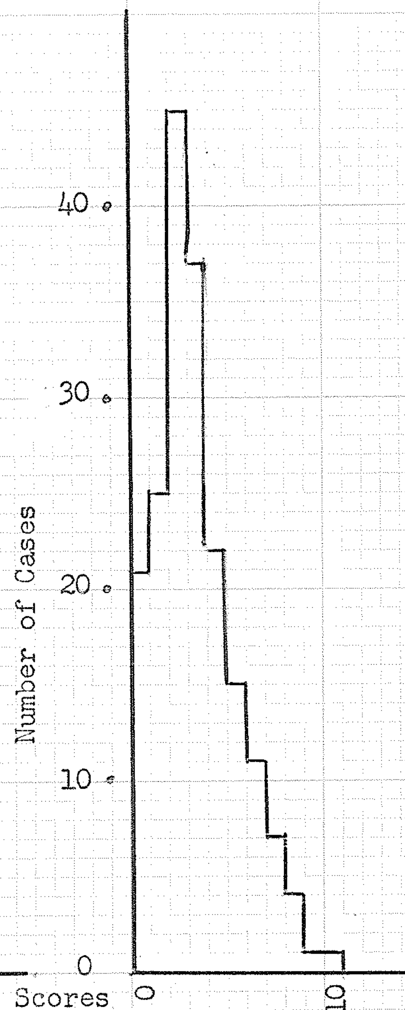

Fig. V. — Histogram of Scores of Control Groups on Power Test, Part Three, June.

TABLE 17. Gain in Total of Parts One and Two of Power Test from March to June.

	Groups																					
	Experimental											Control										
Gain	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
34										1	1											0
33											0											0
32											0											0
31								1			1											0
30										1	1											0
29			1								1											0
28	1										1											0
27		1									1											0
26	2			1							3											0
25		1		2						1	4								1			1
24			1	2							3											0
23	1	1	1	1	1				1	1	7						1		1			2
22	1			1	1	1	1	1		2	8									1		1
21	1	1					1	1			4									1	2	3
20	1	1	1		1			3	1	1	9					1						1
19	1	1		1	1			1		1	6				1		1		2			4
18	1	2	1		1	2			2		9		1				4	2		1		8
17	2	1	1	7	1	1		1	1		15		1		1		2		2		1	7
16		3		3	3	3	1	2	2	1	18						1	1	1			3
15	1				1			1	2		5		1		1	2	2		1	3	1	11
14	2		1		2	1			1	2	9		1		1		1	3	1	1		8

TABLE 17. Continued

Gain	Experimental #2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total	Control #2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total
13			2	1	3	2	2	1	2	3	16			1		1	1	1	2	1	1	8
12		1	2		2	2	1	3		1	12	1		1	2	2	1		5	1	1	14
11		1	1	1	1	1				1	6	1					1		1	1		4
10	4		1	1	3		5	2	1	2	19	1	1	1	4	2		2	2	4		17
9		1		2		2	1	1			7	3				4	1				2	10
8	1	1		2	1	1	2		3		11	1			2	3		1		2		9
7	1		2	1		2	2				8	1		1	1	3	1	2	1		1	11
6	2	3		1	1					1	8		1	1					1	3		6
5			1		1	2	1		1		6	1		2	1	4	1	2	1	2		14
4	1		2			1	1			1	6						1			1		2
3	1	4	2	1		2					10			4	2	3		1			1	11
2				1		1		1			3	1	1	2	1	1	1	1				8
1	1	1	1				2		1		6	1		4	1	1		1				8
0	1										1		2	1					1		1	5
-1			1		1	1					3	2		2								4
-2											0		1	1								2
-3					1	1					2					1			1		1	3
-4											0	1										1
-8											0			1							1	2
-13											0					1						1
	26	24	22	29	26	26	20	19	18	20	230	14	10	22	18	29	20	17	24	22	13	189

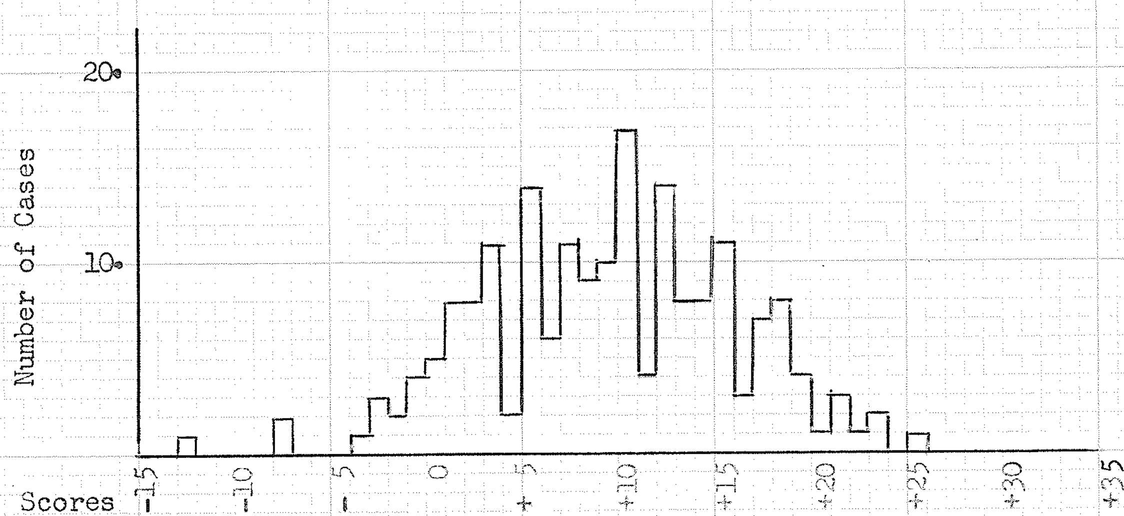

Fig. W. -- Histogram of Gains Scored by Control Groups on Parts One and Two of Power Test from March to June.

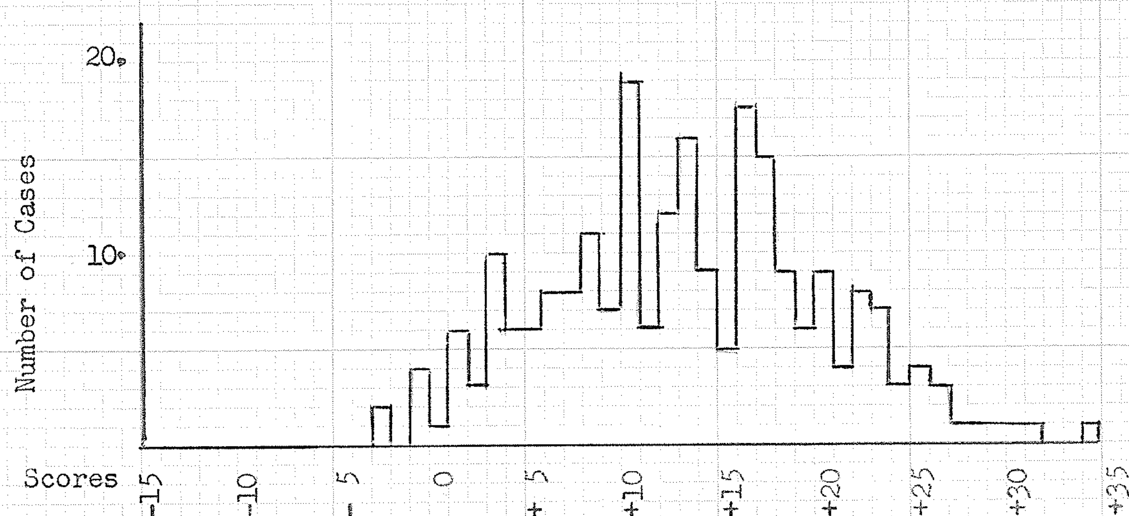

Fig. X. -- Histogram of Gains Scored by Experimental Groups on Parts One and Two of Power Test from March to June.

gain made by a member of the control groups (Table 17) was 25, while 13 members of the experimental groups made gains of 25 or higher, the highest gain being 34 points. In the experimental groups, one child showed no gain, and 6 children negative gains ranging from -1 to -4. In the control groups, 5 children showed no gain and 13 children negative gains ranging from -1 to -13.

From March to June, on Parts One and Two of the test, the mean gain was 13.04 for the experimental and 8.92 for the control groups.

SUMMARY OF OBJECTIVE RESULTS

Although the control groups were shown to have a slight advantage over the experimental groups in respect to chronological age, in arithmetic readiness, and in intelligence, the experimental groups obtained slightly higher scores than the control groups on Part One of the Power Test in June, and considerably higher scores on Parts Two and Three of the test. In addition, the experimental groups made greater gains than did the control groups on all three parts of the test from March to June.

The difference in the effects of the two methods of teaching arithmetic under comparison seem to be significant. On the basis of the results of the testing programme, it would seem safe to assume that it is possible to teach arithmetic at the Grade One level with a higher degree of competence by using the Cuisenaire method than by using the traditional method.

RESULTS OF THE QUESTIONNAIRE TO THE EXPERIMENTAL TEACHERS

All ten of the experimental teachers to whom the questionnaire (Appendix T) was sent completed their questionnaires and returned them to the writer. Their replies to the twenty-five questions are set out below.

Do you consider that by using the Cuisenaire materials during the past year you have achieved better results than you probably would have achieved in the same time without the materials?

Reply:	Yes	No	Not sure	unable to answer
Number:	10			

Comments:

1. One teacher thought the better results were mostely with the bright student.
2. One thought that the results were better because of the enthusiasm evidenced by the pupils.

Do you think that with the aid of the Cuisenaire materials, your pupils tended to be less readily frustrated than formerly?

Reply:	Yes	No	Not sure	unable to answer
Number:	9		1	

Comments:

1. One teacher noticed that the slower children showed signs of frustration at times.
2. One teacher did not think that there was much sign of frustration, but that what little there was may have been caused by her lack of familiarity with the method.

Schonell states, "Most of the difficulty in arithmetic arises because we hurry children too much in the early stages."[3] Do you consider that with the aid of the

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3. Fred J. Schonell and F. Eleanor Schonell, Diagnosis and Remedial Teaching in Arithmetic (Edinburgh: Oliver and Boyd, 1957), p.12.

anything worth while with the rods.

If you were to teach the Cuisenaire method to Grade One another year, how many periods or parts of periods would you set aside for exploration?

Replies:

The answers varied from one to ten full periods. Several teachers thought the children should be allowed to explore during part of every period, because through manipulating the rods, in the free period the children learned the relationships between the rods. Three teachers said that the amount of time set aside for exploration would depend entirely upon the type of class.

Did you find it was generally better to give time for exploration at the beginning or at the end of the period? Why?

Comments:

1. One teacher gave time for exploration at the beginning of the period because through exploration the children became familiar with the rods and built up a certain confidence. This confidence made them willing to be guided into realizing the importance of the facts they had discovered.

2. Two teachers sometimes gave the free time at the beginning and sometimes at the end of the period.

3. The remaining seven teachers gave the free time at the end of the period, their reason being that some of the children used the knowledge gained during the lesson to discover things on their own.

Did you teach the fact that rods of the same colour are also of the same length, or did you wait until the children discovered the fact for themselves?

Replies:

1. The children in six of the classes discovered the fact for themselves.

frustrated than formerly?

Reply	Yes	No	Not sure	Unable to answer
Number	9		2	3

Comments:

1. One principal reported that the children showed as much frustration in dealing with abstract numbers after being exposed to the rods as did those who had not used the rods.

2. One supervisor was not sure about the slower pupils. She considered that they tended to become frustrated when working with fractions.

Schonell states, "Most of the difficulty in arithmetic arises because we hurry children too much in the early stages."[4] Do you consider that with the aid of the Cuisenaire materials it was possible to proceed firmly and quickly during the early stages, and to do so with safety?

Reply	Yes	No	Not sure	Unable to answer
Number	7	1	5	1

Comments:

1. One of the supervisors replied, "With brighter children perhaps, with slower children, no".

2. Another supervisor noted that progress during the first two or three months was quite slow but after that it accelerated.

3. One principal answered, "Yes", to "firmly", but was unable to answer in regard to "quickly".

4. One principal thought that much time should be spent in acquainting the children with the various colour families and with the relative sizes of the rods.

5. One principal who answered, "Not sure", thought that in her school the experimental class had proceeded too quickly and not firmly enough.

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4. Fred. J. Schonell and F. Eleanor Schonell, Diagnosis and Remedial Teaching in Arithmetic (Edinburgh: Oliver and Boyd, 1957), p. 12.

4. "The method allowed the shy retiring type of child to do a good job in experimenting with the rods, whereas another method might not have produced the same results."

5. "Diagnosis of difficulties was apparent through physical manipulation of the rods."

Do you foresee any difficulties to which use of the Cuisenaire materials may later give rise?

Comments:

1. Five respondents did not foresee any difficulties, but agreed that intelligent and gradual tapering off was required.

2. Two supervisors thought that the children were inclined to become too dependent upon the rods.

3. One principal deplored the lack of problem work included in the Cuisenaire course, and felt this lack would lead to difficulty in applying the arithmetic that had been learned.

4. One principal thought more teacher training was necessary if the method were to be employed adequately.

5. One principal reported that the wooden rods became soiled quite quickly. He also reported that the colours were not true. He suggested that plastic rods might be more durable and more easily cleaned.

6. One principal who taught arithmetic to a Grade Six class was worried about the type of arithmetic he would be expected to teach to his Grade Six class in a few years, if the children made as much progress in arithmetic each year as they had during the year of the experiment.

Will you please give any other information about your use of the Cuisenaire materials that you think may be of interest?

Comments:

Six of the fourteen persons questioned gave no

6. The greater variety of activity.

One principal thought that the children enjoyed arithmetic because they could see their way, and were not plunged into the abstract before they were ready for it.

It was the opinion of one principal that the children were happy because their hands as well as their minds were busy when they were manipulating the rods.

One principal traced the children's enjoyment to the lack of frustration experienced.

From your observations last year would you like to see additional classes taught by the Cuisenaire method this year?

Replies:

All fourteen persons answered, "Yes", to this question. One principal added, "I would like <u>all</u> primary classes to use this method." Two principals and two supervisors qualified their replies by saying:

1. "For the good average to very bright pupils, yes; for the slow pupils, doubtful."

2. "Slow children do not do significantly better with this method. Additional classes for bright children might be considered."

3. "Teachers using the method should understand it thoroughly before they begin to teach it."

4. "If additional classes are to be taught by the Cuisenaire method on an experimental basis, the results should be subjectively and not objectively estimated."

In summary, the majority of principals, vice-principals and supervisors agreed that skill in addition, subtraction and multiplication was more easily and quickly developed with than without the Cuisenaire materials. All agreed that

Cuisenaire materials it was possible to proceed firmly and quickly during the early stages, and to do so with safety?

Reply:	Yes	No	Not sure	Unable to answer
Number:	5	2	3	

Comments:

1. One teacher thought it possible to proceed firmly but was not sure about being able to proceed quickly during the early stages.

2. Two teachers said that if they were teaching the Cuisenaire method again they would proceed a little more slowly during the early stages.

3. One teacher said she could answer "Yes" for the children in her A and B groups, but would have to answer "No" for the children in her C groups.

(The two teachers who answered "No" had very slow groups).

Would you predict that for a substantial number of pupils:

(a) skill in addition may be more quickly and easily developed with than without the Cuisenaire materials?

Reply:	Yes	No	Not sure	Unable to answer
Number:	9		1	

(b) skill in subtraction may be more quickly and easily developed with than without the Cuisenaire materials?

Reply:	Yes	No	Not sure	Unable to answer
Number:	9		1	

(c) multiplication tables may be more effectively mastered in a shorter period of time with than without the Cuisenaire materials?

Reply:	Yes	No	Not sure	Unable to answer
Number:	8	1	1	

Did you experience any difficulty in weaning your pupils away from using the Cuisenaire materials?

Reply:	Yes	No	Not sure	Unable to answer
Number:	3	6	1	

Comments:

All of the replies indicated that the teachers found no difficulty in "weaning" the brighter children away from the Cuisenaire materials, but they encountered difficulty with the slower children who had trouble dealing with the more complex number patterns without using the rods.

Although you were asked to limit the time spent on teaching arithmetic to twenty minutes per day during the experiment, did you feel inclined to devote more time than this to arithmetic?

Reply:	Yes	No	Not sure	Unable to answer
Number:	5	4	1	

Comments:

1. Two teachers said that they felt inclined to devote more than twenty minutes per day to arithmetic but that they followed instruction rather than their inclinations.

2. One teacher said that the children enjoyed arithmetic so much using the Cuisenaire method and she enjoyed teaching it so much that she tended to prolong such an enjoyable activity.

3. Two other teachers said they found it quite difficult to limit their arithmetic lessons to twenty minutes per day.

How many periods or parts of periods did you allow at the outset, for unaided exploration with the Cuiseanaire materials?

Replies:

1. Two teachers replied that they allowed very few periods for unaided exploration because the children just built castles or towers. Some oral directions and questions were necessary for the pupils to realize that the rods had a purpose.

2. Three teachers allowed from ten to twenty 15 minute periods for unaided exploration.

3. The remaining five teachers allowed a few minutes at the beginning of each arithmetic period for this purpose. While the children were exploring with the rods, the teacher made suggestions to those children who did not appear to be doing

2. In the other four classes some direction was necessary to point this out to the slower children.

Approximately how long did it take your pupils to learn to link colour and length (the unstained rod taken as unit)?

Replies:

The replies varied from "Almost immediately", to "Approximately three months".

Please give examples of one or two of the more striking "discoveries" that the children made for themselves.

Replies:

The following "discoveries" were reported:

1. Some of the brighter children discovered very early that the red rod was half of the crimson and that the light green was half of the dark green.

2. They discovered that each number was made up of several combinations such as: 1 + 2 + 2 = 5
3 + 1 + 1 = 5 2 + 3 = 5 3 + 2 = 5

3. One child observed that one half of five was two and one half of one, (a red rod and a half of an unstained one).

4. One pupil discovered that the question, "How much is ½ of 12? " had the same answer as the question, "How much is 2/4 of 12?" Another discovered that 2/3 of 9 was equivalent to 3/4 of 8.

5. In one of the slowest groups, the children discovered for themselves the relationship between addition and multiplication, as they noticed that 2 x 3 had the same answer as 3 + 3.

6. Although only the numbers from one to ten were taught, one child in an accelerated group discovered that there were four fives in twenty.

She reasoned that since there are two fives in ten, and two tens in twenty, there must be four fives in twenty.

7. In one of the slower groups the children discovered such relationships as, "The four rod is 4/5 of the five rod," and "The five rod is 5/4 of the four rod."

When using the Cuisenaire materials, do you think that working in groups assisted the learning process? Why?

Comments:

All ten teachers agreed that working in groups assisted the learning process. Some of the reasons given were:

1. The slow ones can proceed at their own speed.
2. The bright ones can progress beyond the usual Grade One programme.
3. The teacher can spot the child having difficulties when she is working with only ten or twelve pupils.

What do you think is the optimum size of group?

Replies:

1. One teacher thought that six was the optimum size for slow children, but that up to thirty would be satisfactory for bright children.

2. The other nine teachers thought ten to fifteen was the optimum size, depending upon the type of class.

What do you think is the best sort of grouping? (e.g. sexes separate, dull children with bright children, etc)? Why?

Comments:

1. Nine teachers thought that ability grouping was best because only by this type of grouping could the children proceed at approximately their own speed.

2. One teacher reported that for variety she sometimes allowed a slow child to sit with a brighter child. In this way the slow child learned from the brighter one.

3. One teacher thought that it did not matter how the children were grouped.

When using the Cuisenaire materials was there any evidence of a different rate of learning between the sexes? If so, which way?

Comments:

1. Nine teachers reported no evidence of difference between the sexes in rate of learning.

2. One teacher said that the boys were a little faster than the girls.

Did the materials appeal more to the one sex than to the other? If so, to which one?

Replies:

1. Eight teachers reported no apparent difference.

2. Two teachers noted that the boys were more inclined to build during free time than were the girls.

What "crutches " did you allow?

No teachers allowed any crutches in addition to the rods.

Were you able to gain information by observing a child working with the rods that you might not have obtained otherwise.

Comments:

Two teachers replied in the negative. The remaining eight teachers stated that they did gain information by observing their pupils manipulating the rods.

1. One teacher considered that she could tell the way the child was thinking by watching him select rods in building number facts.

2. Another teacher found she could tell why a child made errors by watching him manipulate the rods.

3. Another found that two shy children had more ability than they had appeared to have, and that a few precocious pupils did not have as much ability as they had appeared to have.

4. Two teachers said that by watching the children working with the rods, they knew immediately whether or not they had grasped such concepts as 1/3, 2/5, or the idea of multiplying or dividing.

When did you begin to teach fractions?

Replies:

All the teachers introduced the idea of fractions with the number 2. As soon as the children knew that 1 + 1 = 2 they found out that 1 was ½ of 2.

How did you teach the concept of zero?

Replies:

The following replies were received:

1. "In talking about the rods it was agreed that there was no zero rod because it would not count for anything. It was pointed out by the teacher that a number plus zero would not change the answer."

2. "A pupil discovered the concept of zero, and this discovery was discussed with the other pupils".

3. "The concept of zero was not taught, but the children discovered that any rod to remain its own length must have no other rod added to it,

or subtracted from it."

4. "The discovery was made in building up patterns, 5 + 0 = 5 5 - 0 = 5".

5. "When no rod is needed to complete a pattern, nothing is needed. We call this zero. 4 + 0 = 4 5 - 5 = 0."

6. "When the children mastered the idea of 'nothing' in sums like 4 + 0, 3 - 0, the term 'nothing' was changed to 'zero'."

Do you foresee any difficulties to which use of the Cuisenaire materials may later give rise?

Comments:

1. Seven teachers foresaw no difficulties whatever, provided the children were weaned off the rods gradually.

2. One teacher doubted that the children would be able to make the transfer from the concrete to the abstract when they were required to get their answers without the help of the rods.

3. One teacher thought that the lack of problem material found in the course was a weakness.

4. One teacher was concerned about her pupils' concept of fractional parts. She felt that because the children had been taught only to understand a fraction as a part of a whole, as 1/3 x 9 = 3, they might experience difficulty in understanding fractions such as 1/3 as standing for one out of a group or collection of three units.

Will you please give any other information about your use of the Cuisenaire materials that you think may be of interest.

Comments:

Five of the ten teachers did not reply to this question. The other five teachers reported:

1. "Parents are enthusiastic about the Cuisenaire method; so are the children; so is the teacher".

2. "The method is excellent for helping slow children get a number sense. However, for such children, the Grade One course should be cut down to addition and subtraction, with no multiplication, division, or sums involving the use of fractions."

3. "The concreteness and colour of the materials hold a strong appeal to children".

4. "The slow children did not accomplish much more than they would have done by the traditional method, but the bright children accomplished far more, and the method presented a great challenge to them".

5. "The great amount of work involving such fractions as 2/7, 4/9, 6/10 was difficult for all but the very brightest children; and proved frustrating to the rest of the children."

From your own experience do you feel that the children you have taught by the Cuisenaire method enjoyed arithmetic more than the children you have taught by other methods? If so, to what do you attribute this enjoyment?

Comments:

Only one negative reply was received. The teacher who replied , "No", thought that the children derived greater enjoyment from other methods which made use of a variety of tangible materials, than from the Cuisenaire method.

The nine teachers who answered, "Yes", attributed the children's enjoyment to:

1. The experience of manipulating the rods.
2. The sense of achievement in creating patterns with the rods.
3. The bright colours.
4. The teacher's enthusiasm for the method.
5. Something new and different.
6. The thrill of discovery.
7. The lack of frustration.

Did you enjoy instructing with the Cuisenaire materials to the extent that you would like to continue to use them another year?

Comments:

All ten teachers answered "Yes" to this question.

1. The teacher who gave the negative answer to the preceding question said that while she had enjoyed instructing with the Cuisenaire materials, she would like to feel free to combine the Cuisenaire method with other methods when she thought a child would benefit from such a combination of methods.

2. One teacher said she would like to teach the method another year because she knew she could profit from her mistakes made during the first year, and do a better job the second year.

3. One teacher said she would like to continue teaching the Cuisenaire method, but in order to make a better job of her teaching she would like a text with more explicit directions and a teacher's manual written in more simplified language than the one now published.

In summary, the views of the experimental teachers regarding the effectiveness of the Cuisenaire materials were:

1. All the experimental teachers enjoyed instructing with the materials to the extent that they would have liked to continue using them another year. However, one teacher qualified her statement by saying she would prefer to teach a combination of Cuisenaire and other methods.

2. All but one teacher thought that the children enjoyed being taught by the Cuisenaire method more than by any method they had previously employed.

3. All ten teachers considered that by using the materials, they had achieved better results than they probably would have achieved without the materials.

4. All but one teacher predicted that for a substantial number of pupils, skill in addition, subtraction and multiplication might be more quickly and easily developed with than without the Cuisenaire materials.

RESULTS OF QUESTIONNAIRE SENT TO PRINCIPALS, VICE-PRINCIPALS, AND PRIMARY SUPERVISORS

Sixteen questionnaires were sent out. Fourteen were completed and returned to the writer. The replies to the seventeen questions are set out below.

Do you consider that by using the Cuisenaire materials during the past year, better results were achieved than probably would have been achieved in the same time without the materials?

Reply	Yes	No	Not sure	Unable to answer
Number	12		1	1

Comments:

1. One supervisor who answered, "Yes", qualified her statement by adding, "By average and above average pupils".

2. Two principals suggested that the interest and enthusiasm of the pupils in something new aided in producing better results.

3. One principal qualified her affirmative reply by saying, "However, one must take into account the general effect of <u>any</u> experiment".

Do you think that with the aid of the Cuisenaire materials, the pupils tended to be less readily

Would you predict that for a substantial number of pupils:

(a) skill in addition may be more quickly and easily developed with than without the Cuisenaire materials?

Reply	Yes	No	Not sure	Unable to answer
Number	10		2	2

Comments:

One of the principals who answered, "Not sure", said that the materials were fine for good or average pupils, but that slower pupils had experienced trouble learning addition and subtraction facts, even with the help of the materials.

(b) skill in subtraction may be more quickly and easily developed with than without the Cuisenaire materials?

Reply	Yes	No	Not sure	Unable to answer
Number	11		2	1

(c) multiplication tables may be more effectively mastered in a shorter period of time with than without the Cuisenaire materials?

Reply	Yes	No	Not sure	Unable to answer
Number	9		4	1

There were no comments in response to parts B and C of this question.

Do you think that the teachers in the experiment experienced difficulty in weaning their pupils away from using the Cuisenaire materials?

Reply	Yes	No	Not sure	Unable to answer
Number	3	9	1	1

Comments:

1. Three principals said that bright pupils made the transfer from the concrete to the abstract easily, but that slower pupils found the transfer very difficult.

2. Two principals said that slower children were harder to wean away from the materials, as was to be expected, but they did not consider this a serious problem.

Although the teachers were asked to limit the time spent on teaching arithmetic to twenty minutes per day during the experiment, do you think the experimental teachers were inclined to devote more time than this to arithmetic? If so, why?

Reply	Yes	No	Not sure	Unable to answer
Number	3	7	3	1

Comments:

1. One supervisor said that the teachers in whom she was interested did limit the time, but that they felt they needed more time for the slower children.

2. Three principals suspected that the periods were slightly prolonged in schools other than their own.

Did you witness any striking "discoveries" that the children made for themselves.

Comments:

1. Eight of the principals and supervisors reported that they had not observed any such discoveries, but that the class teacher had done so.

2. One principal noted that the children began very early to work out questions mentally and did not reply on the rods.

3. One principal considered that the two most striking aspects he observed were:

   (a) Seeing very young children discover relationships.

   (b) Seeing them work their way through involved calculation series.

4. One principal observed children discovering new combinations to make a given number, such as:

   $7 = 1 + 3 + 1 + 2$ $\qquad$ $7 = 4 + 2 + 1$

When using the Cuisenaire materials, do you think that working in groups assisted the learning process? Why?

Comments:

All fourteen replies to this question were in the affirmative. Some of the reasons given were:

1. "Children looked at their neighbour's rods and thus confirmed their own experiment".

2. "The variety of responses stimulated the pupils' thinking".

3. "It made observation of operations much easier".

4. "Smallness of the rods required that pupils be fairly close to the demonstrator. Therefore, the class must be divided into groups".

5. "Grouping allowed children to proceed at approximately their own speed. The bright children progressed and understood arithmetic far beyond the usual Grade One level".

6. "The slower ones were encouraged, guided and prompted by the brighter ones".

7. "Ability grouping made it possible for the teacher to differentiate instruction so that all the groups would benefit".

8. "Slower children required longer periods of free play. Brighter children could proceed much more quickly".

9. "When the children were grouped there was likely to be thorough mastery of each step, since each child had the time he needed to discover meaningful relationships through manipulation.

What do you think is the optimum size of group?

The replies varied from, "Ten", to, "Fifteen children".

What do you think is the best sort of grouping? (e.g. sexes separate, dull children with bright children, etc.)? Why?

All fourteen persons agreed that ability grouping was the best type of grouping. The general opinion was that ability grouping allowed the brighter children to be challenged, and helped prevent the slower children being frustrated.

As you witnessed the children working with the Cuisenaire materials, was there any evidence of a different rate of learning between the sexes? If so, which way?

No such differences were observed.

Did the materials seem to appeal more to the one sex than to the other? If so, to which one?

No difference was observed. There was general agreement that the materials appealed to all the children. One principal noticed that the boys found a greater variety of mechanical uses for the rods than did the girls, but the girls seemed to be more attracted by the colours than were the boys.

Were you able to gain information by observing a child working with the rods that you might not have obtained otherwise?

Comments:

Five persons could not answer this question. The remaining nine replied in the affirmative. Some of the observations recorded were:

1. "It was easier to follow the child's reasoning process."

2. "It was something like having a child do a problem aloud."

3. "Any observed operation yields information about a child."

reply to this request. The remaining eight persons volunteered the following information:

1. "The experiment created a real and worthwhile interest among other staff members."

2. "It created interest both at school and in the home."

3. "Parents were enthusiastic about the method. They were anxious for their younger children at kindergarten and at home to be taught the Cuisenaire method when they entered Grade One."

4. "Teachers who had experimented with the method wished to continue to use it another year."

5. "Enough time was not allowed at the beginning for free discovery."

6. "Children who learned arithmetic by the Cuisenaire method did not learn the usual arithmetic language."

7. "In a classroom where discipline was not on a high level, the loss of rods was great."

Do you think that the children you observed being taught by the Cuisenaire method enjoyed arithmetic more than those you observed taught by the Jolly Numbers method? If so, to what do you attribute this additional enjoyment?

Comments:

All replies to this question were in the affirmative. However, one principal qualified his answer by saying that with a good teacher either method would be effective.

The additional enjoyment experienced by children taught by the Cuisenaire method was attributed to:

1. The novelty of the blocks.
2. The multi-sensory approach - the visual and tactile factors.
3. The enthusiasm of the teachers.
4. The joy of discovery.
5. The feeling of mastery of facts. The joy of success.

better results had been achieved by using the materials than probably would have been achieved without the materials. All agreed that the children they observed being taught by the Cuisenaire method enjoyed arithmetic more than those they observed being taught the Living Arithmetic Series. From their observations during the experiment, all agreed that they would like to see additional classes taught by the Cuisenaire method during the coming year.

CHAPTER V

CONCLUSIONS

LIMITATIONS OF THE STUDY

In a scientific laboratory experiment, all factors are kept constant, a discrete variable is introduced, and the reactions are recorded. In an experiment involving human behaviour, it is a virtual impossibility to keep all factors constant. However, in the case of the study being reported, if it may be assumed: that the teachers of the experimental and of the control groups were equally competent; that each experimental group had been matched with a control group in respect to type of class; that each experimental school had been matched with a control school in respect to size and to socio-economic area; that an equal amount of time had been spent on arithmetic by all groups; that the children in the experiment were approximately equal in respect to chronological age, intelligence and arithmetic readiness, that the criterion of achievement had been a valid test; then it would seem safe to say that the only discernible variable was the method of instruction which varied with the two groups.

However, one must be careful about making generalizations, and to assume that the method of instruction was the only variable would not be absolutely correct. Several other factors must be considered.

1. The Cuisenaire method of teaching arithmetic was

novel. It is a well known fact that enthusiasm for something new can produce biased results. It remains to be seen whether and to what extent this enthusiasm will be maintained. The children in the experimental groups were known to be intensely interested in working with the Cuisenaire materials. This interest can be expected to remain constant at the Grade One level from year to year, because each year there will be a new group of Grade One children working with the materials, but whether or not teacher enthusiasm will be sustained is something no one can safely predict.

2. In the experimental classes, where the teachers were so enthusiastic about the method, it would seem that there might have been a tendency to prolong the arithmetic periods. All teachers of experimental classes stated in the questionnaire that they had kept the teaching time constant, but it would seem safe to assume that they may have prolonged a pleasurable activity unconsciously. If the time factor were not kept constant for both groups throughout the experiment, the results would be biased.

3. Teacher ability enters into any teaching procedure and is impossible to measure objectively. In this study, all the teachers were considered above average by Mr. Thomson, the Assistant Superintendent, all had previous experience teaching the type of class and in the type of socio-economic area to which they were assigned during the experiment, but because of the many variables which enter into classroom pro-

cedure, it is impossible to equate two classroom situations with precision. Differences in classroom atmosphere, and in rapport between teacher and pupils would produce biased results.

The teachers of the control groups had the advantage of teaching a method with which they had had previous experience. The teachers of the experimental classes were relatively inexperienced with the Cuisenaire method and the Cuisenaire materials. This inequality of experience between the two groups would tend to produce biased results.

CONCLUSIONS

In respect to chronological age, arithmetic readiness, and intelligence, the control groups had a slight advantage over the experimental groups. In spite of this advantage, however, the control scores were lower than the experimental scores on all sections of the Power Test in June.

The statistical findings can be summarized as follows:

1. At the end of the experimental period there was a slight difference in favour of the experimental groups in ability to do the basic arithmetic of the prescribed course authorized by the Minister of Education for the Province of Manitoba.

2. During the period from March to June the children in the experimental groups made greater gains than did the children in the control groups in their ability to do the prescribed course of arithmetic and in their ability to apply their arithmetical learnings.

3. At the end of the experimental period, the children in the experimental groups had surpassed the children in the control groups in ability to apply their computational skills and mathematical understandings in new or unfamiliar situations. With forty-six items on this section of the test, the mean score of the experimental groups was 4.52 greater than that of the control groups.

4. During the period of the experiment, in addition to achieving equal competence on the work of the prescribed course, and developing greater ability in applying their computational skills and mathematical understandings than did the control groups, the children in the experimental groups made significant progress in multiplication, in division, and in working out sums involving fractional parts of abstract numbers.

The subjective results obtained by means of the questionnaires indicated that:

1. The pupils using the Cuisenaire materials developed skills in addition, in subtraction and in multiplication more quickly and more easily.

2. The Cuisenaire method seemed to be especially good for bright children because it presented such a challenge to them.

3. All persons concerned with the experimental classes agreed that the children in these classes enjoyed arithmetic more than those they observed being taught by the traditional method.

4. All teachers and administrators involved in the experiment were unanimous in their opinion that the Cuisenaire materials be used on a larger scale in the future.

The effects of any teaching method are cumulative. Only by conducting an experiment of much longer duration than that reported in this study could the real differences of the effects of the two methods of teaching arithmetic be properly assessed. However, it would seem justifiable to attribute the superior performance of the children in the experimental classes to the independent variable introduced in the experiment, that is, the method used of teaching them arithmetic.

From the results of this experiment, the writer concludes that the Cuisenaire method is a generally better method of teaching arithmetic to children at the Grade One level than that being employed at present in the Winnipeg schools. She suggests that the Cuisenaire method continue to be used in teaching the 230 children in the experimental groups as they proceed through the elementary grades, and that the results be assessed from time to time.

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APPENDIX A

ANALYSIS OF CONTENT OF GRADE ONE PROGRAMMES OF TEN ARITHMETIC SERIES

Topic	Jolly Numbers Living Arithmetic Series	Cuisenaire	Numbers Tell Their Story	Understanding Arithmetic	Exploring Arithmetic	Numbers We See. The Basic Mathematics Programme	Making Sure of Arithmetic	Number Round - Up	Arithmetic in My World	Carpenter-Clark (Find Out About Numbers)
<u>Addition:</u>										
Sum of	9	10	10	6			6	10	9	6
Horizontal form	x	x	x	x				x	x	x
Vertical form	x		x	x			x	x	x	x
Number of addends	3	4	2	3			2	3	4	2
Column addition	x			x						
<u>Subtraction:</u>										
Minuend of	9	10	10	6			6	10	9	6
Horizontal form	x	x	x	x				x	x	x
Vertical form	x		x	x			x	x	x	x
<u>Multiplication:</u>		all facts to 10		to 3 two's		all facts to 10			all facts to 9	
<u>Division:</u>										
Division with remainder						x				

x - indicates those taught

APPENDIX A

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
Fractions:										
One-half of an object	x		x	x	x		x	x		x
One-half of a group			x	x	x					
Fractions with abstract numbers		all fractions to 10/10								
Symbolic forms:										
+ (and)	x	x	x	x			x	x	x	x
= (are)	x	x	x	x			x	x	x	x
- (take away)	x	x	x	x			x	x	x	x
x (times)		x							x	
( ) (brackets)		x								
¢ (cents)	x		x	x	x	x	x	x	x	x
Counting:										
Rational counting of objects by one's (Enumeration)				to 9	to 100	to 10	to 20	to 10	to 12	to 10
Counting to find 'how many'	to 100		to 100	to 10	to 100				to 8	to 50
Counting by 2's				to 8	to 32			to 16		
Counting by 3's				to 9	to 18			to 9		
Counting by 4's					to 20					
Counting by 5's			to 50		to 50			to 100		to 50

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Topic	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
Counting by 10's	to 100		to 100	to 100						to 50
Reversed counting			to 100	to 3	to 20			to 7		
<u>Estimation:</u>										
Size of group (without counting)	to 10		to 10	to 9		to 10	to 10		to 9	to 6
Length (without measuring)			to 10 inches							
<u>Matching groups Recognition of:</u>										
The smallest group				among 3			among 3			
The largest group				among 3			among 3			
The smallest number				among 3						
The largest number				among 3						
<u>Geometric shapes</u>										
Recognition of: □ ▭ △ ○			x		x				x	x
Recognition of: 0					x					
Written forms: square, circle, triangle, rectangle			x						x	x
<u>Reproduction of pictorial Representations to:</u>	8		10		8		6	10		

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
Reading numerals to:	100	10	100	50	100	100	150	100	9	50
Writing numerals to:	100	10	100	50	100	20	100	100	9	50
Serial order of numbers to:	100		100		90	20	100	100		50
Association of number word with number symbol to:	ten	ten	ten	nine	twelve		six	six	nine	ten
<u>Oral Problems involving</u>: Money										
penny or cent	x		x	x	x	x	x	x	x	x
nickel			x	x	x	x	x	x	x	x
dime			x	x	x	x	x	x	x	x
half-dollar and dollar							x			
Telling time in:										
hours			x	x	x		x	x	x	
half-hours					x					
5 minutes					x					
Months, weeks, days,					x	x				
Minutes					x					
<u>Measurement to</u>:			10 inches		8 inches	10				
<u>Reading the thermometer</u>					x					
<u>Reading the calendar</u>					x					
<u>Addition facts</u>:	x		x	x	x	x	x	x	x	x
<u>Subtraction facts</u>	x		x	x	x	x	x	x	x	x
<u>Multiplication facts</u>					x	x			x	

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
Ordinals	to 8th		to 5th	to 5th					to 7th	to 10th
Selection of process:										
Necessary to solution of a problem	x		x							
Where abstract numbers are involved			x							
Odd and even numbers					to 20					
Concepts of weight:										
Pound				x	x					
Ounce					x					
Concepts of liquid measure:										
Gallon				x						
Quart				x	x			x		
Pint					x			x		
Cup					x					
Verbal concepts-size										
tall						x			x	
taller				x	x				x	
tallest				x					x	
larger	x		x	x			x			
largest	x		x	x	x					

APPENDIX A

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
short						x			x	
shorter			x	x			x		x	
shortest				x		x		x	x	
big				x		x			x	
bigger		x							x	
biggest		x						x	x	
small	x	x				x			x	
smaller			x	x			x		x	
smallest	x	x	x	x				x	x	
long						x			x	
longer			x	x		x	x		x	
longest				x				x	x	
the same size				x						
little				x		x			x	
too long, too short, just right, too big, too little					x					
little				x		x			x	
<u>Position:</u>										
first, next							x			
last				x			x			
below							x			
over							x		x	
above				x						
under			x				x		x	
before, after	x		x					x		
between			x							

APPENDIX A

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
top, bottom			x	x			x		x	
middle				x						
on			x							
right, left		x	x	x			x		x	
high, higher, highest									x	
low, lower, lowest									x	
front, back									x	
here, there									x	
<u>Quantity</u>:										
few				x		x			x	
fewer	x			x		x			x	x
fewest									x	
enough, not enough				x	x	x				
too many				x						
more	x	x	x	x		x	x		x	x
less			x	x					x	
many				x		x			x	
most				x	x				x	
a little more			x							
too many					x	x				
as many as						x	x			
not as many as, all,						x				
too few, more than enough						x				
least				x						
<u>Verbal concepts of subtraction</u>:										
subtract	x									
How many more are needed?			x		x					

APPENDIX A

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
less	x									
take away	x	x	x				x	x	x	
difference	x			x	x					
How many are left?	x	x					x	x	x	
number gone, remainder	x									
minus		x								
How many more?		x			x					x
smaller than					x					
<u>Verbal concepts of addition</u>:										
How many in all?	x				x		x	x		x
add		x						x		
and								x	x	
<u>Verbal concepts of division</u>:										
How many?	x								x	
How many times?		x								
<u>Verbal concepts of zero</u>:										
no difference				x						
nothing left			x	x						
not any	x		x	x						
nothing	x									
<u>Miscellaneous verbal concepts</u>										
heavier					x					
about, almost, exactly, not quite,			x							

APPENDIX A

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Topic	Name of Series									
	L. A. S.	C.	N. T. T. S.	U. A.	E. A.	T. B. M. P.	M. S. O. A.	N. R. U.	A. I. M. W.	F. O. A. N.
the same				x						
equal to		x								
couple										x
pair			x	x		x			x	x
score	x									
Which comes next?					x					
Are there enough?					x					
dozen								x		x
whole story	x							x		

APPENDIX B

INITIAL TEST BASIC GRADE ONE NUMBERWORK (VANCOUVER)

School.................Name.................February 16,1959

4 + 1 =

1 + 3 =

3 + 3 =

7 + 1 =

2 + 3 =

1	1	9	3	5
+5	+2	+1	+2	+5
___	___	___	___	___

2 + 1 + 1 =

---

6 - 1 =

5 - 2 =

10 - 5 =

4 - 2 =

5 - 1 =

4	5	3	5	6
-1	-0	-2	-3	-3
___	___	___	___	___

Fill in the missing numbers.

7 ____, 9.

11, 12, ______.

____, 4, _____.

APPENDIX C

FINAL TEST - BASIC GRADE ONE NUMBERWORK (VANCOUVER)

Name.................

---

1 + 9 =	5 + 4 =	3 + = 7
3 + 4 =	10 - 7 =	6 - 5 =
8 - 5 =	8 - 0 =	9 - = 2

24	4	52	17	6	46	78
+5	+6	-2	-5	-0	+3	+1

91	3	10	57	7	36	12
+8	+7	-6	-6	+7	-3	+3

Put in the missing numbers:

15, 20, 25, __, __, 40.

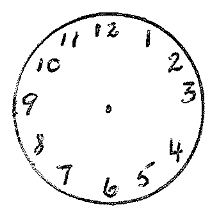
26, 28, __, __, 34.

7, 17, 27, __, __, 57.

12, 11, __,

__, 70, __, 90.

Make the clock say 10 o'clock.



Add:

5	13	20
2	3	2
4	2	2
	1	2

Jack had 10 horses and 3 horses ran away.
There are ___ horses left.

Jane put 4 balls in the box. Dick put 3 balls in the box and Sally put 1 ball in the box.
How many balls are in the box? ______

APPENDIX D

TEST OF CONTENT TAUGHT WITH CUISENAIRE MATERIALS (VANCOUVER)

Name........................

$1 + \quad = 2$

$1 + 1 + 1 =$

$3 - \quad = 1$

$3 = 2 +$

$1 + 2 + \quad = 4$

$2 + \quad + 1 = 4$

$5 - 4 =$

$2 + \quad + 1 = 5$

$4 = 5 -$

$5 - (3 + 1) =$

$2 \times 3 =$

$5 \times 3 =$

$(2 \times 2) + 1 =$

$(2 \times 3) - 1 =$

$1 \times 4 =$

$3 \times (1 + 1) =$

$4 = 2 \times$

$5 - (1 \times 1) =$

$(2 \times 1) + 2 =$

$4 - (2 + \quad) = 1$

$\frac{1}{2} \times 2 =$

$\frac{1}{2} \times 4 =$

$2 = \frac{1}{2} \times$

$(\frac{1}{2} \times 4) + 1 =$

$\frac{1}{2} \times 2 + \frac{1}{2} \times 4 =$

$3 - (\frac{1}{2} \times 2) =$

$2 + (\frac{1}{2} \times 2) + (\frac{1}{2} \times 4) =$

$3/2 \times (3 + 1) =$

$1/3 \times 3 =$

$4/3 \times 3 =$

$4 \times 2 =$

$8 = 2 \times 2 +$

$8 + 7 =$

$1 + 2 + 3 + \quad =8$

$2/5 \times 5 + 3/4 \times 4 = 8 -$

$1/7 \times (8 -1) =$

$9 - 1 + 2 - 3 =$

$1/7 \times (9-2) + 1/8 \times (9 - 1) + 3/5 \times (9 + 1) =$

$1/10 \times (2 \times 2 * 2 \times 3)=$

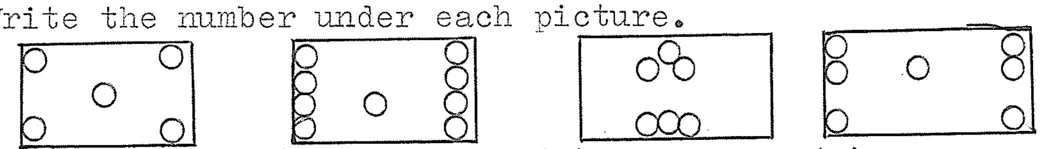
$4/9 \times (4 + 5) =$

APPENDIX E

ARITHMETIC TEST: GRADE ONE (SASKATCHEWAN)

Page 1

1. Write the number under each picture.



(a)______ (b) ______ (c)_______ (d)_______

2. Write the missing numbers in the boxes.

(a)

4	5	6		8	

(b)

9	10		12		

(c)

	40	41			44

3. Count by 2's

2	4	6			

4. Count by 10's.

20	30	40		60	

5. Count by 3's.

3	6	9			

APPENDIX E

Page 2

6. Write the number story that this picture tells.

0 0 0	0 0 0 0

___ + ___ = ___

7. Put X on the fourth ball.

Make the sixth ball black.

0 0 0 0 0 0 0 0

8. Add:

(a) 2 3	(b) 6 1	(c) 8 5	(d) 9 9	(e) 6 7

Grade 1.

9. Subtract:

(a) 6 3	(b) 8 6	(c) 10 3	(d) 13 9	(e) 17 8

10.

(a) 4 + 5 =	(b) 2 and 2 are ___	(c) 6 and 4 are
(d) 1 + 9 =	(e) 8 + 7 =	(f) 3 + 8 =

11.

(a) 4 from 5 leaves _____	(b) 1 from 9 leaves ___	(c) 7 - 5 =
(d) 16 - 9 =	(e) 12 - 4 =	(f) 11 - 8 =

12.

(a) 2 + 1 + 2 =	(b) 6 + = 11	(c) 9 + = 16
(d) 13 - = 8	(e) 4 + 4 + 3 =	(f) 3 + 3 - 2 =

13.

(a) 5 +3	(b) 9 -4	(c) 8 +9	(d) 15 -6	(e) 14 -9

14.

(a) 13 +4	(b) 2 +15	(c) 21 +6	(d) 35 +4	(e) 6 +43

15.

(a) 29 -7	(b) 36 -4	(c) 48 -8	(d) 54 -3	(e) 89 -5

16.

Add: (a) 2 6 6	(b) 9 2 9	(c) 51 12 23	(d) 32 74 51	(e) 63 60 76

17.

(a) 140 +300	(b) 143 +35	(c) 39 -13	(d) 68 -64	(e) 97 -63

18. In 86 there are __ tens and __ ones.

19. In 427 there are __ hundreds.

20.

(a) Five 2's =	(b) How many 2's in8?
(c) How many 3's in 9?	(d) Two 6's =
(e) How many 4's in 12?	(f) Three 2's =

APPENDIX F

TEST OF ARITHMETIC FUNDAMENTALS
GRADE ONE (SASKATCHEWAN)

1. Write the numbers that are left out:

   8, 9, ___, 11, ___,

   46, ___, 48, 49, ___.

2. Write the number after:

   60, ___. 99, ___.

3. Write the number before:

   ___, 40. ___, 71.

4. Count by 2's:

   14, ___, ___, 20.

   9, 11, ___, ___.

5. Count by 10's:

   40, 50, ___, ___.

6. Count by 3's:

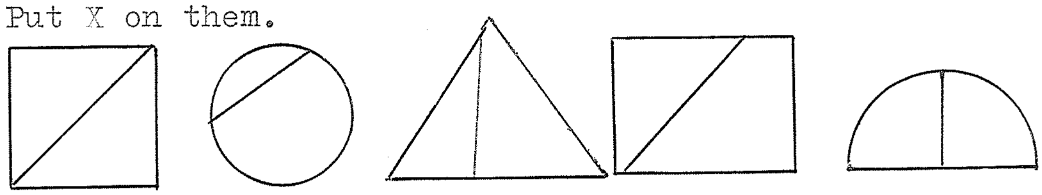
   6, 9, 12, ___, ___.

7. Count by 5's:

   15, 20, 25, ___, ___.

8. Draw 10 balls.
   Colour half of the balls.

9. Which show one-half?
   Put X on them.



10. Add:

5	2	8	7	21
4	8	6	9	8

APPENDIX F

Page 2

11.	Subtract:	9	10	13	17	29
		6	4	5	8	5

12. Do what the signs say:

3	9	11	6	12
+7	-4	-6	+7	-8
4	15	25	4	27
+8	+5	-5	+22	-6

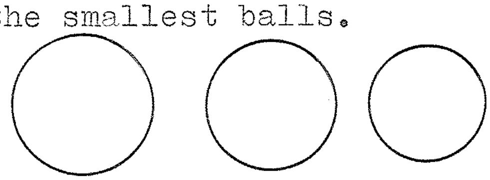
13.	2 + 4 + 3 =	9= ____ +6	10 - ____ = 3
	3 + 2 + ____ = 10	____ - 5 = 3	6 + 4 + 7 =
	16 - ____ = 8	9 - 7 + 6 =	6 + 8 - 5 =

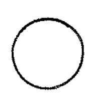
14.	Add:	4	7	9	33	40
		4	5	2	84	67
		2	7	9	51	60

15.	Subtract:	18	29	48	87	98
		7	8	8	15	26

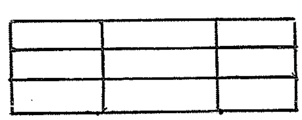
16. Put X on the longest line.

17. Colour the smallest balls.



18. Draw a ball bigger than this ball. 

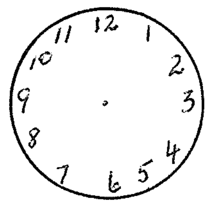
19. Put X in the middle.



APPENDIX F

Page 3

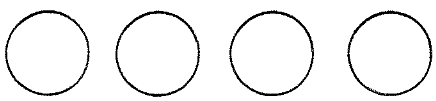
20. Draw the hands to show 7 o'clock.



21. Draw a ring around the smallest number.

26 17 24 30

22. Draw more balls so you will have 10 in all.



23. 16 = _____ ten and _________

2 tens and 4 ones = ________

One-half of 10 is ________

2 from 10 leaves________

Six 2's = ____________

How many 5's are there in 15? _______

How many 2's are there in 10?________

Three 3's = ________

Four 10's = __________

½ x 4 + ¼ x 4 = ________

2/3 x 6 = ___________

6 - (4 + 1) = _________

8 - ¼ x 4 = _________

APPENDIX F
Page 4

One foot = ____ inches

3 x 3 + _____ = 10

How many 4's are there in 12?

Four 4's = ________

Three 5's and 2 = ________

APPENDIX G

SCHONELL'S DIAGNOSTIC ARITHMETIC TESTS

These are all "ADD" sums.
Work across the page.

A.	1 + 1 =	0 + 0 =	2 + 1 =	2 + 2 =	1 + 3 =
B.	2 + 0 =	3 + 1 =	3 + 3 =	5 + 5 =	4 + 1 =
C.	1 + 6 =	4 + 0 =	4 + 4 =	1 + 7 =	6 + 1 =
D.	7 + 1 =	1 + 8 =	1 + 5 =	5 + 0 =	7 + 7 =
E.	2 + 5 =	3 + 2 =	1 + 4 =	0 + 2 =	6 + 6 =
F.	4 + 3 =	8 + 8 =	2 + 9 =	2 + 8 =	5 + 4 =
G.	9 + 2 =	9 + 1 =	9 + 9 =	3 + 0 =	0 + 7 =
H.	0 + 1 =	6 + 0 =	6 + 2 =	2 + 4 =	0 + 4 =
I.	8 + 2 =	6 + 4 =	1 + 9 =	4 + 5 =	0 + 8 =
J.	8 + 3 =	5 + 1 =	7 + 2 =	0 + 3 =	1 + 2 =
K.	0 + 5 =	4 + 2 =	3 + 6 =	8 + 1 =	0 + 9 =
L.	1 + 0 =	5 + 3 =	2 + 7 =	3 + 5 =	7 + 0 =
M.	2 + 3 =	5 + 2 =	3 + 4 =	8 + 4 =	2 + 6 =
N.	6 + 3 =	4 + 8 =	0 + 6 =	7 + 3 =	8 + 4 =
O.	9 + 0 =	3 + 7 =	6 + 5 =	7 + 4 =	4 + 6 =
P.	3 + 8 =	5 + 6 =	3 + 9 =	7 + 6 =	9 + 3 =
Q.	6 + 7 =	4 + 7 =	8 + 9 =	5 + 7 =	9 + 4 =
R.	7 + 5 =	5 + 9 =	4 + 9 =	8 + 6 =	7 + 8 =
S.	9 + 5 =	8 + 7 =	6 + 9 =	9 + 8 =	9 + 7 =
T.	6 + 8 =	9 + 6 =	8 + 5 =	5 + 8 =	7 + 9 =

These are all "SUBTRACT" or "TAKE AWAY" sums.
Work across the page.

A.	3 - 2 =	1 - 1 =	4 - 2 =	5 - 4 =	0 - 0 =
B.	5 - 3 =	3 - 3 =	5 - 1 =	4 - 4 =	8 - 1 =
C.	6 - 6 =	4 - 3 =	3 - 1 =	2 - 1 =	6 - 5 =
D.	5 - 2 =	6 - 1 =	9 - 1 =	7 - 7 =	9 - 8 =
E.	5 - 5 =	7 - 1 =	6 - 3 =	2 - 2 =	4 - 1 =
F.	6 - 2 =	8 - 4 =	9 - 9 =	7 - 6 =	6 - 4 =
G.	8 - 7 =	9 - 0 =	8 - 5 =	6 - 0 =	8 - 6 =
H.	9 - 5 =	3 - 0 =	8 - 2 =	9 - 3 =	7 - 2 =
I.	10 - 7 =	10 - 1 =	9 - 6 =	5 - 0 =	10 - 2 =
J.	12 - 6 =	7 - 3 =	4 - 0 =	8 - 8 =	1 - 0 =
K.	10 - 4 =	2 - 0 =	7 - 4 =	9 - 7 =	8 - 0 =
L.	9 - 2 =	9 - 4 =	10 - 5 =	7 - 0 =	8 - 5 =
M.	11 - 2 =	10 - 6 =	12 - 8 =	14 - 7 =	12 - 9 =
N.	8 - 3 =	10 - 8 =	11 - 5 =	10 - 9 =	11 - 8 =
O.	10 - 3 =	12 - 4 =	11 - 7 =	16 - 7 =	11 - 9 =
P.	12 - 7 =	12 - 5 =	13 - 6 =	11 - 4 =	18 - 9 =
Q.	11 - 3 =	15 - 8 =	15 - 7 =	11 - 6 =	12 - 3 =
R.	14 - 8 =	15 - 9 =	13 - 8 =	15 - 6 =	13 - 5 =
S.	14 - 6 =	13 - 4 =	17 - 8 =	16 - 9 =	13 - 7 =
T.	17 - 9 =	14 - 5 =	14 - 9 =	13 - 9 =	16 - 7 =

These are all "ADD" sums.
Work across the page.

A.	14	15	12	2	2	10	13	12	11
	+3	+4	+6	+17	+15	+16	+16	+14	+10

APPENDIX G
Page 3

B.	31 +66	65 +22	23 +73	28 +30	123 +45	346 +212	482 +306	543 +126
C.	9 +19	15 +6	6 +17	9 +17	57 +7	58 +6	6 +89	8 +68
D.	87 +31	96 +63	84 +94	50 +81	23 +17	39 +48	14 +79	37 +59
E.	401 +607	209 +39	874 +83	635 +944	56 +69	38 +86	57 +59	54 +97

These are all "SUBTRACT" or "TAKE AWAY" sums.
Work across the page.

A.	98 -3	57 -4	81 -1	38 -8	55 -32	99 -43	78 -10	97 -22
B.	346 -215	987 -832	378 -122	496 -261	18 -14	19 -18	16 -10	17 -15
C.	71 -2	62 -4	46 -7	84 -6	54 -39	22 -17	58 -19	46 -27
D.	331 -18	543 -25	283 -29	786 -58	316 -27	564 -59	68 -59	387 -299

These are all "MULTIPLY" or "TIMES" sums.
Work across the page.

A.	1 x 3 =	2 x 2 =	1 x 7 =	2 x 1 =	1 x 4 =
B.	5 x 1 =	2 x 5 =	1 x 8 =	2 x 8 =	1 x 5 =
C.	4 x 1 =	2 x 3 =	1 x 6 =	3 x 2 =	2 x 9 =
D.	5 x 4 =	2 x 7 =	4 x 4 =	6 x 1 =	5 x 2 =

APPENDIX G
Page 4

E.	3 x 1 =	1 x 9 =	3 x 3 =	3 x 5 =	2 x 6 =
F.	1 x 2 =	4 x 3 =	6 x 2 =	5 x 5 =	6 x 4 =
G.	3 x 6 =	6 x 6 =	3 x 4 =	4 x 5 =	6 x 3 =
H.	6 x 5 =	4 x 2 =	2 x 4 =	5 x 3 =	3 x 9 =
I.	4 x 8 =	5 x 6 =	5 x 8 =	5 x 7 =	3 x 8 =
J.	5 x 9 =	1 x 1 =	6 x 8 =	6 x 9 =	6 x 7 =
K.	4 x 9 =	3 x 7 =	4 x 7 =	4 x 6 =	7 x 1 =

These are all "DIVIDE" sums.
Work across the page.

A.	4 ÷ 2 =	10 ÷ 2 =	9 ÷ 3 =	6 ÷ 2 =	10 ÷ 5 =
B.	15 ÷ 3 =	8 ÷ 2 =	14 ÷ 2 =	20 ÷ 5 =	25 ÷ 5 =
C.	12 ÷ 2 =	16 ÷ 2 =	12 ÷ 6 =	12 ÷ 3 =	15 ÷ 5 =
D.	6 ÷ 3 =	36 ÷ 6 =	40 ÷ 5 =	16 ÷ 4 =	12 ÷ 4 =
E.	30 ÷ 5 =	21 ÷ 3 =	7 ÷ 1 =	4 ÷ 1 =	5 ÷ 1 =
F.	35 ÷ 5 =	6 ÷ 1 =	3 ÷ 1 =	42 ÷ 6 =	18 ÷ 3 =
G.	30 ÷ 6 =	20 ÷ 4 =	8 ÷ 1 =	8 ÷ 4 =	45 ÷ 5 =
H.	9 ÷ 1 =	18 ÷ 2 =	24 ÷ 6 =	32 ÷ 4 =	2 ÷ 1 =
I.	18 ÷ 6 =	24 ÷ 4 =	48 ÷ 6 =	24 ÷ 3 =	27 ÷ 3 =
J.	5 ÷ 5 =	5 ÷ 5 =	54 ÷ 6 =	3 ÷ 3 =	2 ÷ 2 =
K.	36 ÷ 4 =	6 ÷ 6 =	28 ÷ 4 =	1 ÷ 1 = [1]	

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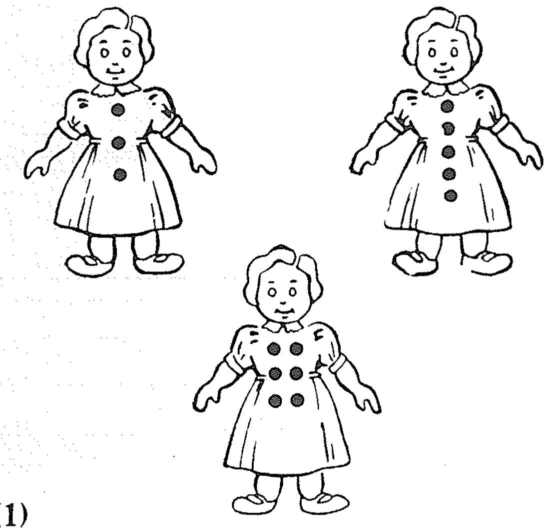
1. Fred J. Schonell and F. Eleanor Schonell, Diagnostic and Attainment Testing, Third Edition, (London: Oliver and Boyd Limited, 1958), pp. 114 - 120.

APPENDIX H

ARITHMETIC READINESS TEST

Page 1

PART A



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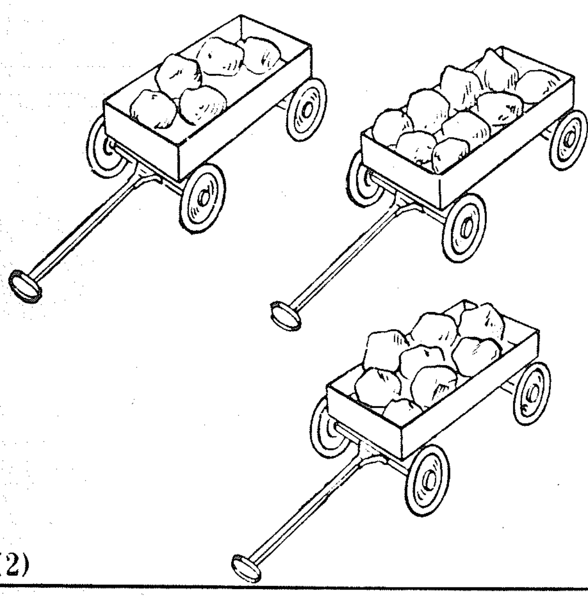
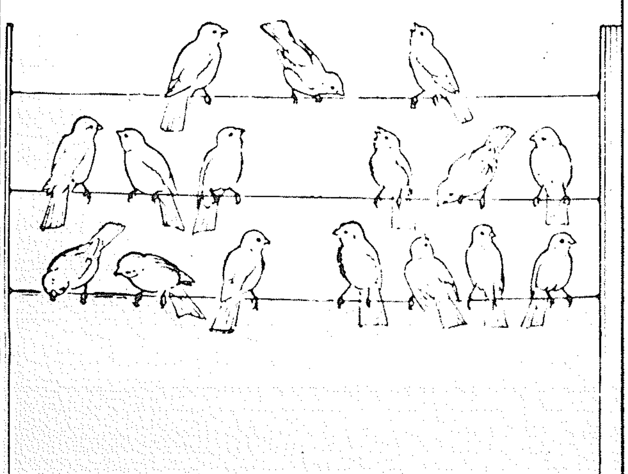
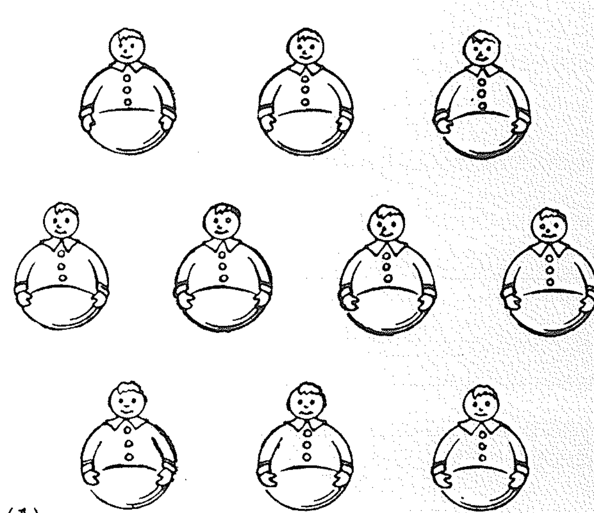


(2)

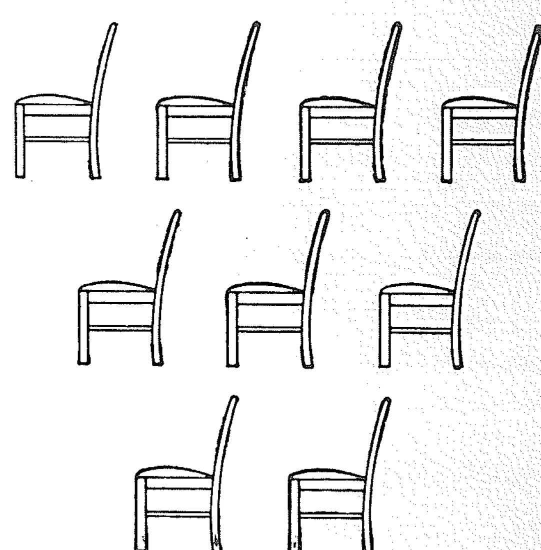


(3)

PART B



(1)



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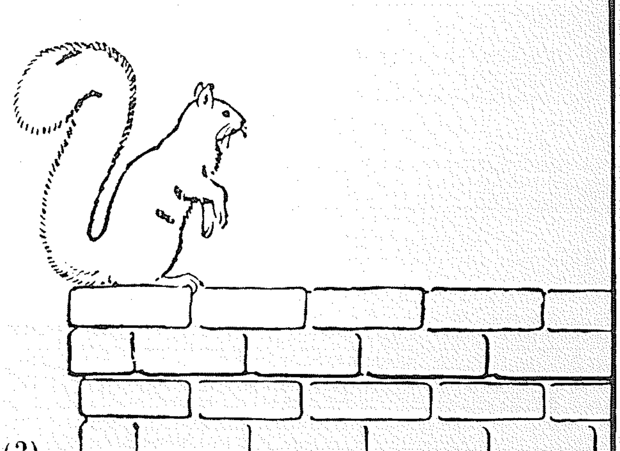
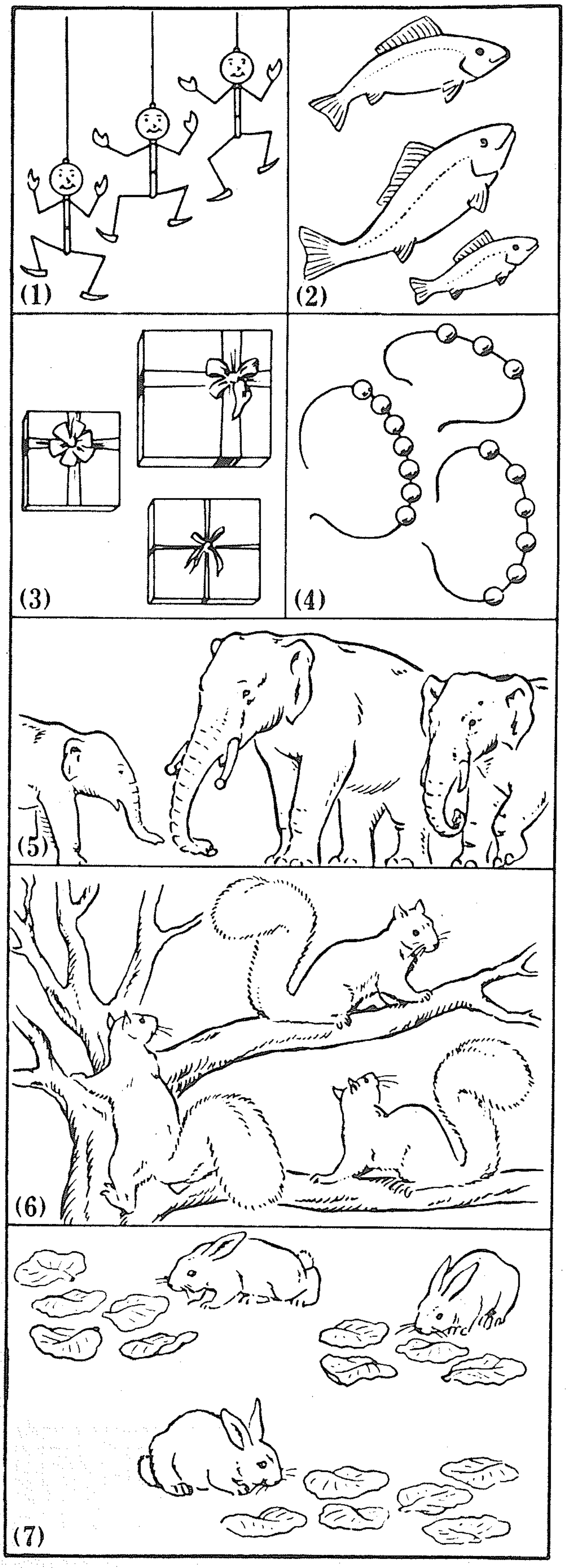


(3)

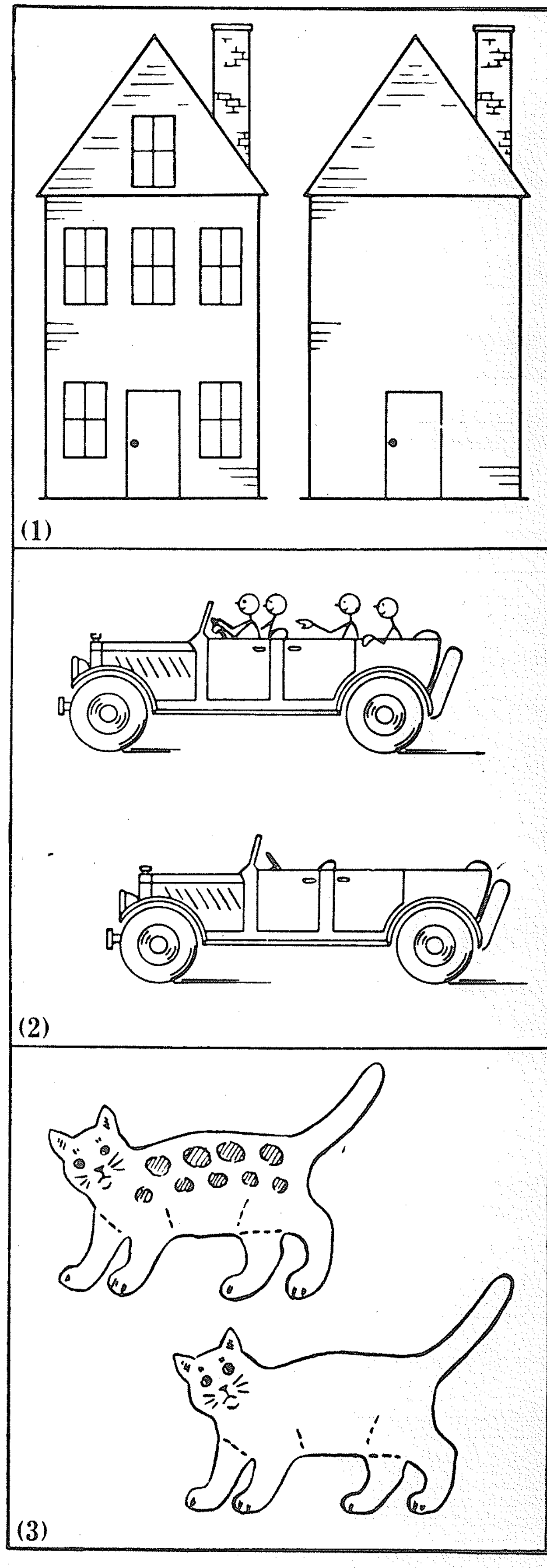
ARITHMETIC READINESS TEST

Page 2

PART C



PART D



APPENDIX I

ARITHMETIC READINESS - Pretest I - Form B

Directions for Administering the Test

Before this test is administered, the directions should be understood thoroughly, and followed explicitly.

1. Acquaint yourself with the scope of the tests and the instructions for administering it.

2. Fill in the required information concerning each child on the test sheets: name, birthdate, school.

3. The test is to be administered to groups of no more than 12 children at one time.

4. Seating is to be arranged so that there will be no opportunity for copying.

5. Each child is to be provided with a sharpened pencil. (A supply of spares should be on hand).

6. In administering the test no instructions to pupils other than those accompanying the test are to be used. If any pupil seems not to understand, simply repeat the instructions.

7. Make certain that the children understand that the items go from top to bottom of the page, not from left to right.

8. Illustrate on the blackboard what you mean by "a mark". Have the children put a large X <u>right through the picture</u>.

9. In Part B, illustrate <u>how to draw</u> a hat for Item I, rockers for Item 2, and nuts for Item III. Do similarly for Part D.

Instructions to be given to pupils when all is ready.

<u>Part A.</u> <u>Identification</u>. 1. Peggy has six buttons on her dress. Put a mark on her dress.
2. Put a mark on the wagon that has nine rocks in it.
3. Put a mark on the wire that has seven birds on it.

<u>Part B.</u> <u>Reproduction.</u> 1. Look at the roly-polys. Draw hats on eight of them.

APPENDIX I

Page 2

2. These chairs have no rockers. Draw rockers on five of the chairs.
3. This squirrel would like some nuts. Draw ten nuts for him.

Part C. Crude Comparison. 1. See the jumping-jacks. Put a mark on the one that has the longest string.
2. Look at the fish. Put a mark on the smallest fish.
3. These are Mary's birthday boxes. Put a mark on the largest one.
4. Find the strings of beads. Put a mark on the string that has the most beads on it.
5. See the elephants. Put a mark on the elephant that has the longest trunk.
6. Which squirrel is highest in the tree? Put a mark on that squirrel.
7. Put a mark on the rabbit that has the smallest number of leaves to eat.

Part D. Exact Comparison. 1. Here are two houses. One house has windows but the other has no windows. Can you put as many windows in this house (pointing to the second house) as there are windows in this house (pointing to the first house)?
2. See these two cars. Draw as many men in this car (pointing to the bottom car) as there are in this car (pointing to the top car).
3. Put as many dots on this cat (pointing to the cat with no dots) as there are on this one (pointing to the cat with dots).

This is not a "timed" test, but when approximately 80% of the group have completed the item "without undue haste or unhealthful strain" move on to the next item.

Results are to be recorded on the accompanying Summary Sheet and returned to the School Board Office together with all of the test papers. If some of the children are unable to take the test because of their inability to follow the instructions their papers are to be returned, and their names included in the summary of results.

APPENDIX J

PRELIMINARY TEST NUMBER ONE

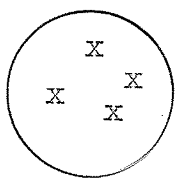
Name........................

Date........................ School.....................

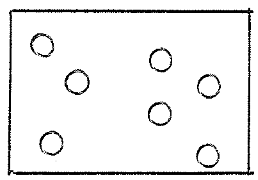
Grade One Arithmetic Part One, Test of Course Authorized by the Minister of Education, Province of Manitoba, 1953.

1. Example a b c

2. Example

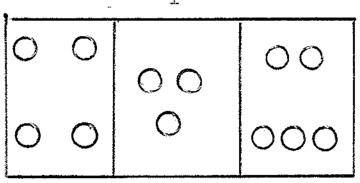


a.

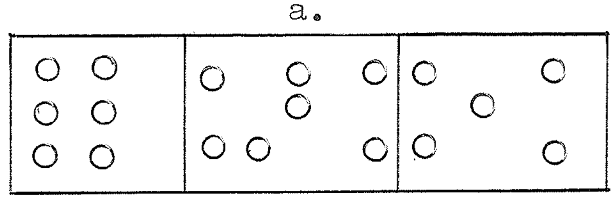


______ ______ b. ______

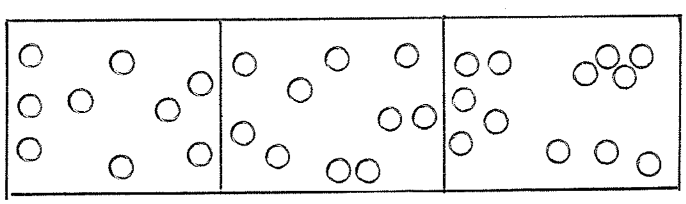
3. Example



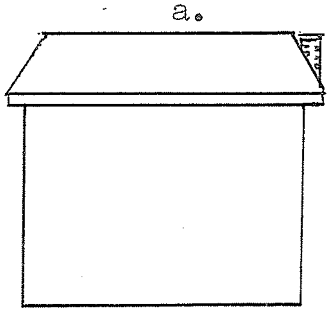
a.



b.

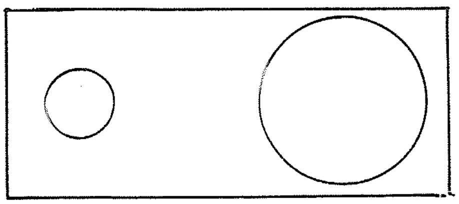


4. a.

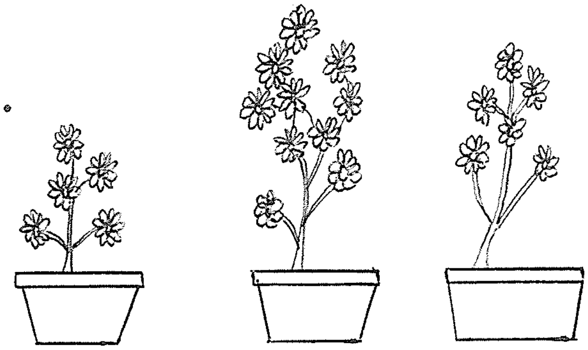


b.

5. Example



a.



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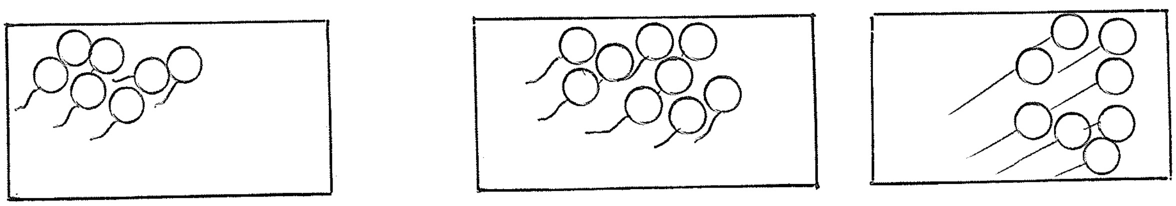
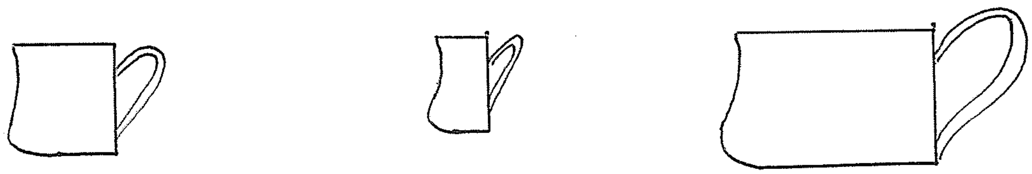
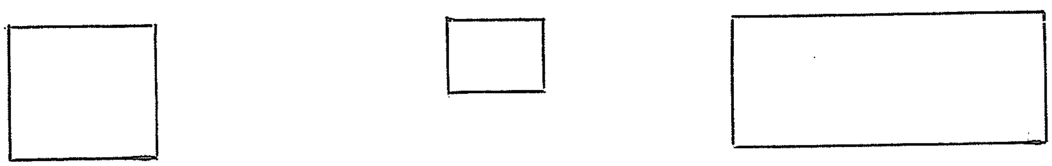


c.



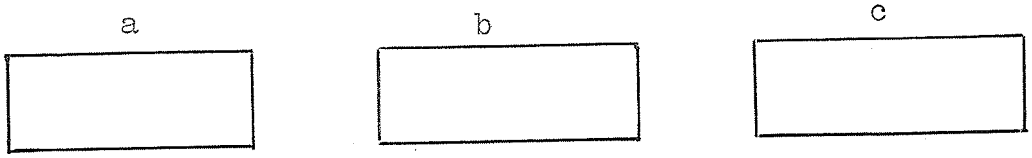
d.



Example	e	f	g	h
5	17	9	32	36
3	12	13	16	59

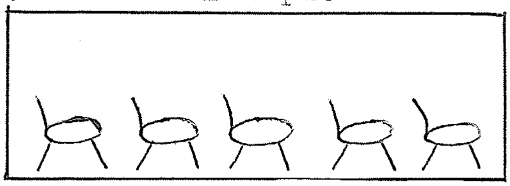
6.

a b c

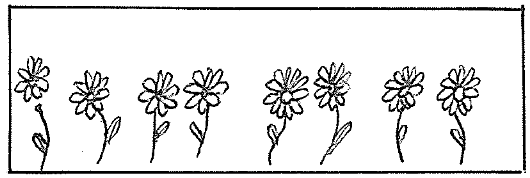


7. Example a b c

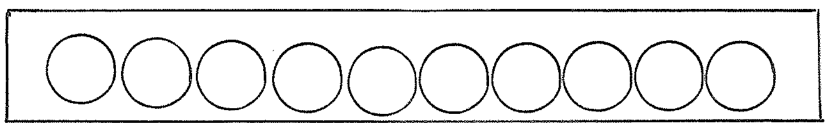
8. Example



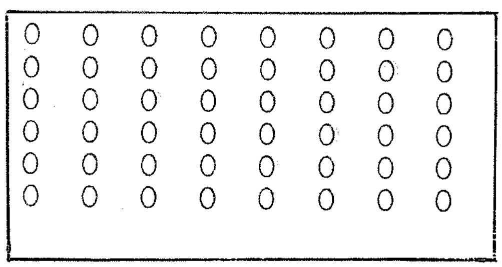
a



b



c



9. Example a b

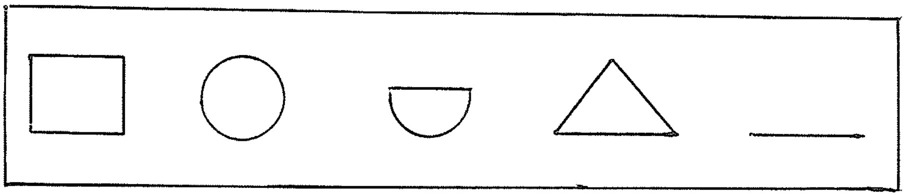
6,6,12

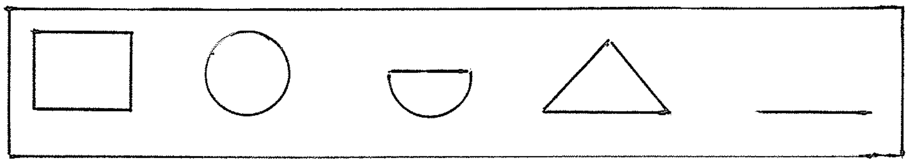
7,9,16

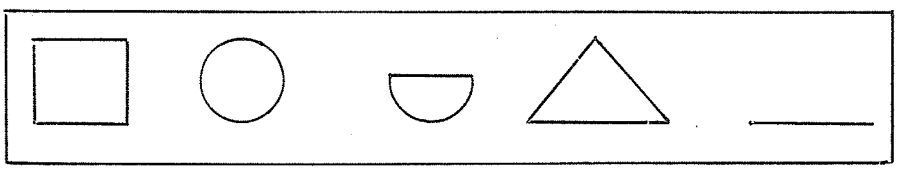
APPENDIX J

Page 4

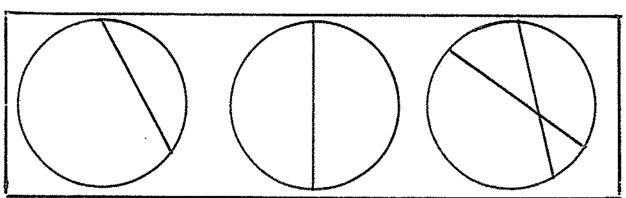
10

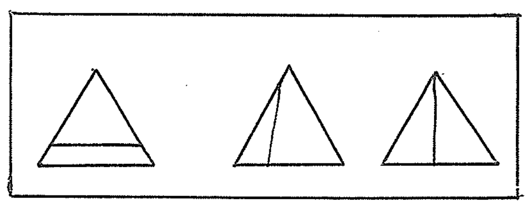
a. 

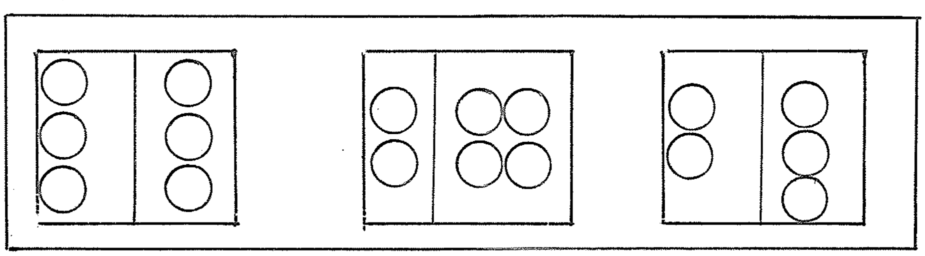
b. 

c. 

11.

a. 

b. 

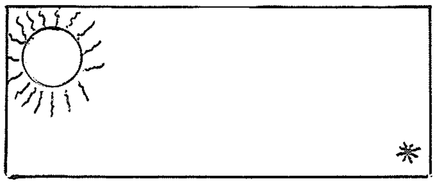
c. 

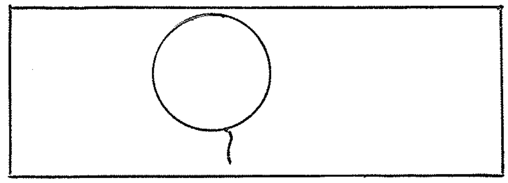
APPENDIX J

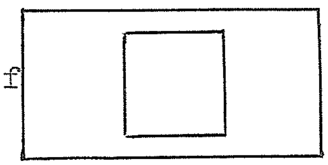
Page 5

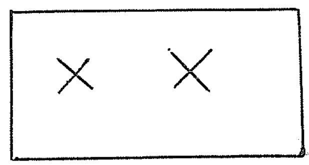
12. a ______________________ b ______________________

c ______________________

d 

e 

f 

g 

13.

a.b.c.	d.e.f.	g.h.i.
9 - 5 =	9 - 3 =	3 + 4 =
2 + 7 =	5 - 0 =	8 - 6 =
7 + 0 =	4 + 5 =	0 + 8 =

14.

a	b	c	d	e
7	9	14	13	6
+5	+7	-9	-9	+8

f	g	h	i	j
8	16	14	9	17
+5	-7	-5	+6	-9

GRADE ONE ARITHMETIC PART 2

TEST OF CONTENT TAUGHT WITH LAZERTE MATERIALS

1\.

Example

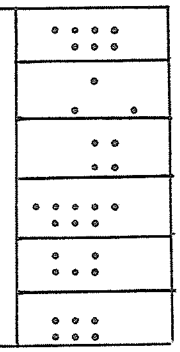
a
b
c

two	7
ten	4
seven	2
five	10
	5
	3

Example

a
b
c

three
eight
six
four



2\.

	a		b
		60	

	c	
74		76

3\.

	a	
7	11	4

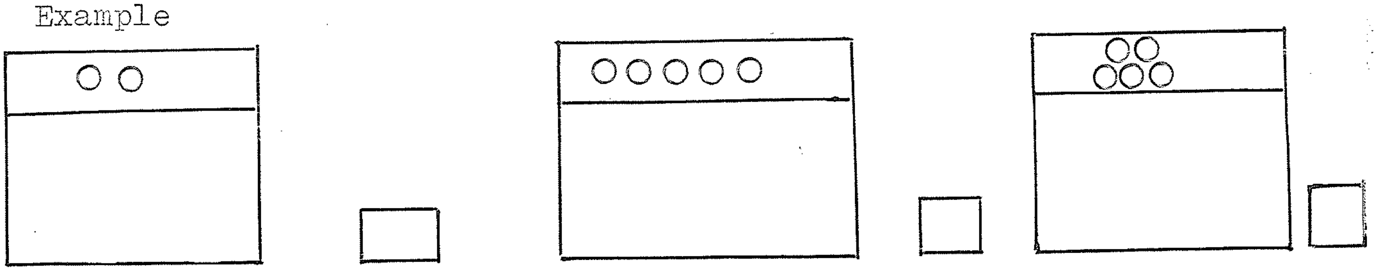
	b	
37	41	29

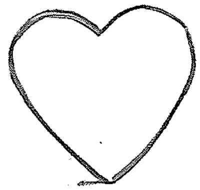
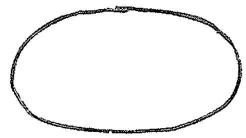
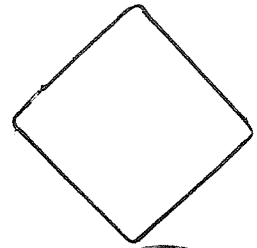
4\. Example

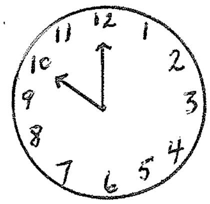
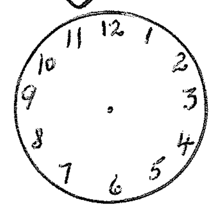
a
b
c

circle
square
rectangle
triangle

5\. Example



6. a  b  c 

7. a $\boxed{}$ o'clock  b 5 o'clock 

8. a b c

9. a $5 \boxed{} 1 = 6$ b $8 \boxed{} 3 = 5$

10. (a) Jane saw 2 yellow birds.
She saw 4 red birds, too.
How many birds did she see?

(a) 1. Add Subtract (a) 2. birds

(b) There were 6 cookies.
The store man sold 3 cookies.
How many were there then?

(b) 1. Add Subtract (b) 2. cookies

11. (a) 72 = $\boxed{}$ tens and $\boxed{}$ ones.

(b) 9 tens and 6 ones = $\boxed{}$

12. (a) 10, 20, __, __, __, 60.

(b) 100, 90, 80, __, __, __, 40.

(c) 5, 10, __, __, __, 30.

(d) 62, 63, __, __, __, 67.

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GRADE ONE ARITHMETIC PART III

TEST OF CONTENT TAUGHT WITH CUISENAIRE MATERIALS

---

1. 3 =   + 2
2. 2 + 1 +   = 4
3. 5 - (1 x 1) =
4. 6 = 1 +   + 2
5. 2 x 2 + 2 =
6. 6 - (2 + 2) =
7. 1 = 3 -
8.   - 2 = 2
9. 3 x (1 + 1) =
10. 1 x 3 + 1 x 2 =

---

11. 5 - (2 x   ) = 1
12. 6 - (½ x   ) = 4
13. 3/2 x 2 + 2/2 x 2=
14. 5/2 x 2 - 4/3 x 3 =
15. ½ x (3 + 1) = ¼(5-1)=
16. 4 + (½ x 2) =
17. 2 + ½ x 2 + ½ x 4 =
18. 2 - (1/3 x 3)=
19. 5 - 4/3 x 3 + 2 =
20. 6 = 2 + 2 x

---

21. 7 - 2 +   = 8
22. 1 + 3 + ½ x 6 + ¼ x 4=
23. 8 - 3/5 x 5 =
24. 9 - ½ x 4 =
25. 8 - ½ x 4 =
26. 1 + 2 + 3 +   = 8
27. 3 x 3 +   = 10
28. ½ x 10 + 1/5 x 10 =

---

29. 1/7 x (9 - 2) + 1/8 (9 -1) + 3/5 (9+1) =
30. 10 - ½ x (7 + 3) = 9 -

APPENDIX K

THE WINNIPEG SCHOOL DIVISION NO. I
Superintendent's Department

GRADE I ARITHMETIC

PRELIMINARY TEST NUMBER ONE

Instructions Part I

1. ROTE COUNTING TO 100: Say, "What number comes after 3? Yes, 4. Let us put the number 4 in the first box (pointing). Now you must do the rest of the row yourselves. What number comes after 7? Put the number in the next box. What number comes after 36? Put the number in the next box. What number comes after 69? Put the number in the last box.".

2. RATIONAL COUNTING AND ENUMERATION TO 100: Say, "Let us count the crosses in this circle (pointing). Yes, there are 4 crosses so we will put the number 4 on the line under the circle." See that the children do it correctly. "Now you must do the rest of the row yourselves. Count the balls in the next box. Put the number on the line under the box. Count the times I rap on the desk. Listen!". Teacher raps 12 times on the desk. "Put the number on the last line."

3. IDENTIFICATION BY ENUMERATION: Say, "Look at this box (pointing). There are 3 groups of marbles in it. Which group shows 5 marbles? Yes, the last group. Let us put a mark under the last group." Teacher shows on the blackboard how to "put a mark" under the last group and sees that the children understand how to do it correctly. "In the next box (pointing) put a mark under the group that has 7 marbles in it. In the last box put a mark under the group that has 12 marbles in it."

4. REPRODUCTION: Say, " Draw 2 doors and 5 windows on this house. Draw 8 balls in the empty box."

5. COMPARISON: Say, (pointing) "Which ball is bigger? Yes, the second ball.
   (a) Let us put a mark under the second ball." See that the children do it correctly. "Put a mark under the plant with the fewest flowers on it. Put a mark under the box which has the most balloons in it. Put

APPENDIX K

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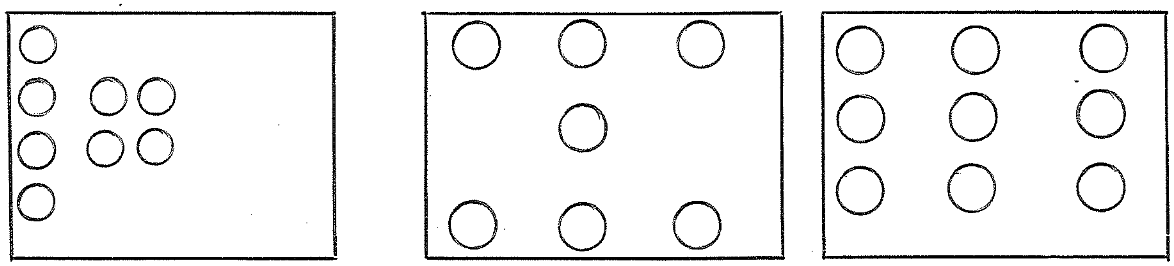
a mark under the smallest cup. Put a mark under the largest box."

5. (b) Say, "Look at the first box (pointing). Which is more, 5 or 3? Yes, 5. "Let us put a mark through the 5." Demonstrate and see that the children do it correctly. "Now you must do the rest of the row yourselves. Which is more, 17 or 12? Put a mark through the number that is more. Which is more, 9 or 13? Put a mark through the number that is more. Which is less 32 or 16? Put a mark through the number that is less. Which is less 36 or 59? Put a mark through the number that is less."

6. FORMING AND RECOGNIZING GROUPS: Teacher holds up manilla 9" x 12" cards one at a time with the following groupings on them.



She gives the pupils sufficient time to see the form of the pattern but not long enough to count the symbols. Say, "How many circles did you see on the card? Write the number in the first box. How many circles did you see on that card? Write the number in the middle box How many circles did you see on that card? Write the number in the last box."

7. READING AND WRITING NUMBERS: Say, "Let us write the number 9 in the first box (pointing). See that the children do it correctly. Write the number 31 in the next box. Write the number 50 in the next box. Write the number 97 in the last box."

8. ORDINALS: Say, "Let us put a ring around the second chair." See that the children do it correctly. "Put a ring around the sixth flower. Put a mark under the eighth ball. Put a mark through the 7th ball in the fifth row."

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9. TELL THE WHOLE STORY ABOUT: Say, "Can you tell the whole story about 2, 1, and 3? Let us do it together on the blackboard.

$$2 + 1 = 3$$
$$1 + 2 = 3$$
$$3 - 1 = 2$$
$$3 - 2 = 1$$

Now we will write the story of 2, 1, and 3 in the first box." See that the children do it correctly, "Now you tell the whole story about the numbers under each box. Write the story inside the box."

10. MEASURES AND GEOMETRIC FIGURES: Say, "Put a mark under the triangle in the first box. Put a mark under the square in the middle box. Put a mark under the half circle in the last box."

11. FRACTIONS: Teacher puts a figure of a square on the blackboard. Say, "Do you think you could draw a line to cut this figure in half? You try it Billy. Did he do it right? Are both pieces exactly the same size? Now look at the figures in these boxes (pointing). Put a mark under the figure in each box that shows one half."

12. VOCABULARY, WORDS RELATING TO SIZE AND POSITION: Teacher puts a figure of a circle on the blackboard. Say, "Who can draw another circle under the one I have made just as big as mine? You try Janie. Did Janie make hers under mine? Did she make it just as big as mine? Is it a little too big? Try again, Janie. Do just as I say. Make it <u>just as big</u> as mine. Now listen children and do exactly <u>what I tell</u> you to do. Make a line <u>under</u> this line (pointing) shorter than this line. Make <u>a line</u> above this line (pointing) just as long as this line. Make a line under this line (pointing) longer than this line. Make another star nearer to the sun than this star (pointing). Make another balloon in front of this balloon (pointing). Make another box ahead of this box (pointing). Make another cross between these crosses (pointing)."

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13. ADDITION AND SUBTRACTION: Say "There are some addition and some subtraction questions in the next box. Do what the sign says. If you come to one that you can't do, leave it out and go on to the next one. When you have finished, put your pencil down."

"In the next box there are some more addition and subtraction questions. Do what the sign says. If you come to one that you cannot do, leave it out and go on to the next one. When you have finished, put your pencil down."

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THE WINNIPEG SCHOOL DIVISION NO. 1.
Superintendent's Department

Instructions - Part II.

1. (a) MATCHING NUMBER SYMBOL WITH CORRESPONDING NUMBER WORDS: Say, "Look at the first box. Who can read the first word (pointing)? Yes, it says TWO. Can you find the number 2 in this column (pointing)? Let us draw a line from the word TWO to the number 2." See that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves. When you are through, put your pencils down."

1. (b) MATCHING NUMBER WORD WITH CORRESPONDING NUMBER OF DOTS: Say. "Look at the next box. Who can read the first word (pointing)? Yes, it says THREE. Can you find a little box in this column(pointing) that has 3 dots in it? Yes, it is the second little box. Let us draw a line from the word THREE to the little box that has 3 dots in it." See that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves. When you are through, put your pencils down".

2. SERIAL ORDER OF NUMBERS: Say, "In this box (pointing) there are 2 empty spaces, one BEFORE the number, and one AFTER the number. You are to write the number that comes BEFORE this number (pointing) in this box (pointing) and the number that comes AFTER this number in this box (pointing)."

"Now look at the next box. Can you write the number that comes BETWEEN these two numbers in the empty space (pointing)?"

3. LARGEST AND SMALLEST OF A GROUP OF THREE: Say, "Look at the 3 numbers in this box, (pointing). Draw a ring around the smallest number. Look at the 3 numbers in the next box (pointing). Draw a ring around the largest number."

4. MATCHING WRITTEN FORM WITH PICTORIAL FORM OF GEOMETRIC FIGURES: Say, "Who can read the first word in this box? Yes, it says CIRCLE. Can you find a picture of a circle in this column (pointing)? Yes

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it is the fourth picture in the column. Let us draw a line from the word CIRCLE to the picture of the circle." See that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves. When you are through put your pencils down."

5. HOW MANY MORE ARE NEEDED? Say, "Look at the first box (pointing). How many more marbles would you need to make 3? Yes, 1. Let's add enough marbles in the lower half of this box (pointing) to make 3 and write the number of marbles we added in this little box (pointing). We put 1 marble in the lower half of the big box so we put the number 1 in the little box." See that the children do it correctly. "Now you must do the next two by yourselves. Look at the next box (pointing). How many more marbles would you need to make 10? Add enough marbles in the lower half of the big box to make 10 and write the number of marbles you added in the little box. Now look at the next box (pointing). How many more marbles would you need to make 9? Add enough marbles in the lower half of the big box to make 9 and write the number of marbles you added in the little box."

6. ONE HALF OF AN OBJECT: Say, "Show me where you would draw a line to cut this heart in half. Now draw a line to cut the next picture in half. Now draw a line to cut the last picture in half." Give no help.

7. TELLING TIME: Say, "Do you know what time it is by this clock (pointing)? Write the time in this little box (pointing). Look at the next clock (pointing). Read what it says under the clock (pointing). Now draw 2 hands and make this clock say the same time as it says under the clock."

8. RECOGNITION OF NUMBERS OFTEN CONFUSED: Say, "There are 2 numbers in each of these 3 boxes (pointing). I will call out one of the numbers in each box and you are to put a circle around the number I call out." Teacher calls out (a) 15. (b) 70 (c) 12.

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9. SELECTION OF APPROPRIATE PROCESS: Teacher writes on the blackboard 2 $\square$ 1 = 1.

Say, "Did I add or subtract to get the answer 1? Yes, I subtracted so I will put a subtraction sign in the box." Teacher writes on the blackboard 2 $\square$ 1 = 3.

Say, "Did I add or subtract to get the answer 3? Yes, I added so I will put an addition sign in the box. Now you look at the next 3 questions (pointing). Think whether you would add or subtract to get each answer, and put the correct sign in the boxes. When you are through put your pencils down."

10. SELECTION AND APPLICATION OF THE APPROPRIATE PROCESS: Say, "Read these 2 problems (pointing). Draw a line under the word at the bottom (pointing) that tells you what to do to find the answer. Write the answer in the little box. When you are through put your pencils down."

11. KNOWLEDGE OF PLACE VALUE OF ABSTRACT NUMBERS: Say, "Look at the next 2 problems (pointing). Put the correct numbers in the little empty boxes."

12. COUNTING AND WRITING NUMBERS: Say, "Write the missing numbers in the empty spaces (pointing). When you are through, put your pencils down."

Instructions - Part III

Say, "Here are some rather odd looking arithmetic questions. Do you think you can do any of them? See if you can. If you come to some that you can't do, don't worry about them. Just leave those out and keep working down the page to see if you can find any that you can do."

APPENDIX L

SUMMARY OF ITEM ANALYSIS, PRELIMINARY
TEST NUMBER ONE

Item Number	Quartile 4. Number of Correct Responses (25 pupils)	Quartile 3. Number of Correct Responses (25 pupils)	Quartile 2. Number of Correct Responses (25 pupils)	Quartile 1. Number of Correct Responses (25 pupils)	Total Number of Correct Responses	Total Number of Incorrect Responses	Index of Difficulty	Index of Discrimination*
Part One								
1a	24	25	24	23	95	4	95%	G
1b	24	19	9	3	55	45	55%	G
1c	22	11	0	2	35	65	35%	G
2a	25	22	24	25	96	4	96%	B
2b	11	10	3	0	24	76	24%	G
3a	25	25	23	24	97	3	97%	G
3b	25	24	22	21	92	8	92%	G
4a	25	22	25	21	93	7	93%	G
4b	25	24	25	23	97	3	97%	G
5a	21	15	18	9	63	37	63%	G
5b	25	21	20	23	89	11	89%	G
5c	25	25	24	25	99	1	99%	B
5d	24	22	22	18	86	14	86%	G
5e	25	25	25	18	93	7	93%	G
5f	25	25	25	20	95	5	95%	G
5g	23	19	23	8	73	27	73%	G
5h	24	17	21	9	71	29	71%	G

* G(good); B(bad); -(no response)

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
6a	19	14	13	4	50	50	50%	G
6b	20	15	19	13	67	33	67%	G
6c	18	12	12	13	55	45	55%	G
7a	25	24	14	3	66	34	66%	G
7b	25	20	4	3	52	48	52%	G
7c	25	23	19	10	77	23	77%	G
8a	25	25	25	16	91	9	91%	G
8b	24	24	25	17	90	10	90%	G
8c	4	6	7	2	19	81	19%	G
9a	2	0	0	0	2	98	2%	G
9b	0	0	0	0	0	100	0%	-
10a	25	22	24	17	88	12	88%	G
10b	24	23	22	21	90	10	90%	G
10c	24	23	22	21	90	10	90%	G
11a	19	15	17	11	62	38	62%	G
11b	19	16	15	9	59	41	59%	G
11c	14	8	4	6	32	68	32%	G
12a	24	24	23	19	90	10	90%	G
12b	24	21	22	18	85	15	85%	G
12c	25	25	24	21	95	5	95%	G
12d	25	23	23	22	93	7	93%	G
12e	14	11	14	9	48	52	48%	G
12f	12	9	14	21	56	44	56%	B
12g	24	24	21	23	92	8	92%	G
13a	14	8	8	3	33	67	33%	G
13b	24	12	10	1	47	53	47%	G
13c	22	18	18	2	50	50	50%	G
13d	16	8	4	2	30	70	30%	G
13e	18	18	7	0	43	57	43%	G
13f	22	14	10	1	47	53	47%	G

APPENDIX L

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
13g	19	18	11	0	48	52	48%	G
13h	14	5	2	0	21	79	21%	G
13i	19	10	4	0	33	67	33%	G
14a	13	1	1	0	15	85	15%	G
14b	6	1	0	0	7	93	7%	G
14c	0	0	0	0	0	100	0%	-
14d	0	0	0	0	0	100	0%	-
14e	5	1	0	0	6	94	6%	G
14f	8	1	1	0	10	90	10%	G
14g	3	0	0	0	3	97	3%	G
14h	3	0	0	0	3	97	3%	G
14i	4	0	0	0	4	96	4%	G
14j	3	0	0	0	3	97	3%	G
Part Two								
1a	25	22	15	10	72	28	72%	G
1b	23	23	15	7	68	32	68%	G
1c	21	24	22	14	81	19	81%	G
1d	22	15	9	5	51	49	51%	G
1e	20	22	23	7	72	28	72%	G
1f	23	23	23	13	82	18	82%	G
2a	23	18	5	4	50	50	50%	G
2b	24	19	8	6	57	43	57%	G
2c	25	23	17	10	75	25	75%	G
3a	20	19	15	8	62	38	62%	G
3b	15	9	1	2	27	73	27%	G
4a	12	6	1	1	20	80	20%	G
4b	1	0	1	0	2	98	2%	G
4c	7	6	4	0	17	83	17%	G
5a	24	16	16	1	57	43	57%	G

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
5b	23	16	15	2	56	44	56%	G
6a	24	24	23	23	94	6	94%	G
6b	25	25	25	21	96	4	96%	G
6c	25	25	25	22	97	3	97%	G
7a	21	18	14	6	59	41	59%	G
7b	19	12	10	3	44	56	44%	G
8a	24	18	17	11	70	30	70%	G
8b	22	20	19	10	71	29	71%	G
8c	25	23	23	11	72	28	72%	G
9a	23	18	12	11	64	36	64%	G
9b	21	13	6	11	51	49	51%	G
10 a_1	1	0	0	0	1	99	1%	G
10 a_2	1	1	0	0	2	98	2%	G
10 b_1	1	0	0	0	1	99	1%	G
10 b_2	1	0	0	0	1	99	1%	G
11a	0	0	0	0	0	100	0%	-
11b	0	0	0	0	0	100	0%	-
12a	20	14	4	0	38	62	38%	G
12b	17	6	1	0	24	76	24%	G
12c	14	1	0	0	15	85	15%	G
12d	15	3	1	1	20	80	20%	G
Part Three								
1	5	0	1	1	7	93	7%	G
2	6	2	0	0	8	92	8%	G
3	1	0	0	0	1	99	1%	G
4	1	0	0	0	1	99	1%	G
5	2	0	0	1	3	97	3%	G
6	4	2	0	0	6	94	6%	G
7	0	0	0	0	0	100	0%	-

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
8	0	0	0	0	0	100	0%	-
9	0	0	0	0	0	100	0%	-
10	0	0	0	0	0	100	0%	-
11	0	0	0	0	0	100	0%	-
12	0	0	0	0	0	100	0%	-
13	0	0	1	0	1	99	1%	-
14	0	0	0	0	0	100	0%	-
15	0	0	0	0	0	100	0%	-
16	0	0	0	0	0	100	0%	-
17	0	0	0	0	0	100	0%	-
18	0	0	0	0	0	100	0%	-
19	0	0	0	0	0	100	0%	-
20	0	0	0	0	0	100	0%	-
21	0	0	0	0	0	100	0%	-
22	0	0	0	0	0	100	0%	-
23	0	0	0	0	0	100	0%	-
24	0	0	0	0	0	100	0%	-
25	0	0	0	0	0	100	0%	-
26	0	0	0	0	0	100	0%	-
27	0	0	0	0	0	100	0%	-
28	0	0	0	0	0	100	0%	-
29	0	0	0	0	0	100	0%	-
30	0	0	0	0	0	100	0%	-

APPENDIX M

THE WINNIPEG SCHOOL DIVISION NO. I
Superintendent's Department

GRADE I ARITHMETIC

PRELIMINARY TEST NUMBER TWO

Instructions Part I

1. COMPARISON: Say, (pointing) "Which ball is bigger? Yes, the second ball. Let us put a mark under the second ball." See that the children do it correctly.

1. a. "Put a mark under the box which has the most balloons in it."
1. b. "Put a mark under the largest box."
1. c. "Put a mark under the plant with the fewest flowers on it."

Say, "Turn over the page. Look at the first box. Which is more, 17 or 12? Yes, 17. Let us put a mark through the 17." See that the children do it correctly.

1. d. "Which is less, 46 or 32? Put a mark through the number that is less."

1. e. "Which is more, 59 or 36? Put a mark through the number that is more."

2. MEASURES AND GEOMETRIC FIGURES: Say, "Put a mark under the triangle in the next box, (pointing)."

3. READING AND WRITING NUMBERS: Say, "Let us write the number 9 in the first box (pointing)." See that the children do it correctly.

3. a. "Write the number 97 in the next box."
3. b. "Write the number 31 in the next box."
3. c. "Write the number 50 in the last box."

4. FORMING AND RECOGNIZING GROUPS: Teacher holds up manilla 9" x 12" cards one at a time with the following groupings on them.

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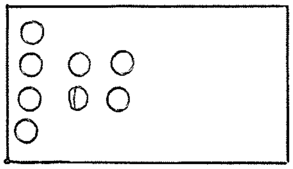
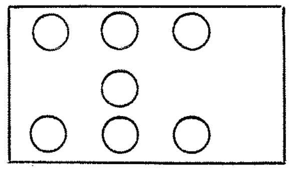
Page 2

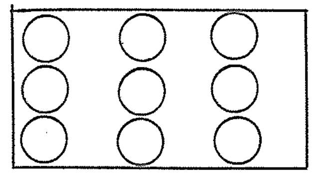
4a.



4b.



4c.



She gives the pupils sufficient time to see the form of the pattern but not long enough to count the symbols.

Say, "I am going to show you a card with some circles on it. I will just hold it up for a few seconds. Watch when I say "Ready?". Write the number of circles that you see in this box, (pointing)."

Teacher proceeds in the same manner for Items 4b and 4c.

5. VOCABULARY, WORDS RELATING TO SIZE AND POSITION: Teacher puts a figure of a circle on the blackboard. She makes a smaller one under it and says, "Did I make this circle (pointing) as big as the first one? I'll try again." She rubs the second circle out and makes one under the first just the same size as the first one. "Are they both the same size now?"

5 a. Say "Now you do just what I say. Make a line above this line(pointing) just as long as this line."

5 b. "Make another balloon in front of this balloon(pointing).

6. FRACTIONS: Teacher puts a figure of a square on the blackboards. She says, "I'm going to see if I can draw a line to cut this figure in half." She draws a line which doesn't cut the figure in half and discusses with the children what is wrong. She tries again and this time cuts the square exactly in half.
6a, 6b, and 6c. Say, "look at the figures in these boxes. Put a mark under the figure in each box that shows one half."

7. ROTE COUNTING TO 100: Say "What number comes after 7? Yes, 8. Let us put the number 8 in

APPENDIX M

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the first box, (pointing). Now you must do the rest of the row yourselves."

7. a. "What number comes after 36? Put the number in the next box."

7. b. "What number comes after 69? Put the number in the last box."

8. ADDITION AND SUBTRACTION: Say, "There are some addition and some subtraction questions in the next box. Do what the sign says. If you come to one that you can't do, leave it out and go on to the next one. When you have finished all you can do, put your pencils down."

9. RATIONAL COUNTING AND ENUMERATION TO 100: Say, "I am going to rap on the desk with the scissors. I want you to count the number of times I rap and write the number on this line, (pointing) "Ready, start counting". Teacher raps 12 times.

10. ORDINALS: Say, "Let us put a mark through the eighth ball." See that the children do it correctly. Say, "In this box, (pointing) put a mark through the 7th ball in the fifth row."

11. ADDITION AND SUBTRACTION (cont'd): Say, "There are some addition and some subtraction questions in the next box. Do what the sign says. If you come to one that you can't do, leave it out and go on to the next one. When you have finished all you can do, put your pencils down."

12. TELL THE WHOLE STORY ABOUT: Say, "Can you tell the whole story about 1, 2 and 3? Let us do it together on the blackboard."

$$2 + 1 = 3$$
$$1 + 2 = 3$$
$$3 - 1 = 2$$
$$3 - 2 = 1$$

APPENDIX M
Page 4

Now we will write the story of 1, 2, and 3 in the first box." See that the children do it correctly. "Now you tell the whole story about the numbers under each box. Write the story inside the box."

Instructions - Part II

1. a.b.c. MATCHING NUMBER SYMBOL WITH CORRESPONDING NUMBER WORD: Say, "Let us look at the first box. What does the first word say (pointing)? Yes, it says TWO. Can you find the number 2 in this column (pointing)? Let us draw a line from the word TWO to the number 2." See that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves."

1. d.e.f. MATCHING NUMBER WORD WITH CORRESPONDING NUMBER OF DOTS: Say, "Look at the next box. What does the first word say (pointing)? Yes, it says THREE. Can you find a little box in this column (pointing) that has 3 dots in it? Let us draw a line from the word THREE to the little box that has 3 dots in it." See that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves."

2. RECOGNITION OF NUMBERS OFTEN CONFUSED: Say, "There are 2 numbers in each of these 3 boxes (pointing). I will call out one of the numbers in each box and you are to put a circle around the number I call out." Teacher calls out:

   a. 20 b.17 c.50

3. SERIAL ORDER OF NUMBERS: Say, "In these boxes (pointing) there are some empty spaces."

   a. "In this box (pointing), write the number that comes between these numbers."

APPENDIX M

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b. "In this box (pointing) write the number that comes before this number, here (pointing) and the number that comes after this number, here (pointing)."

4. SELECTION OF APPROPRIATE PROCESS: Teacher writes on the blackboard 2   1 = 1. Say, "Did I add or subtract to get the answer 1? Yes I subtracted so I will put a subtraction sign in the box." Teacher writes on the blackboard 2   1 = 3. Say, "Did I add or subtract to get the answer 3? Yes, I added so I will put an addition sign in the box. Now you look at the next 2 questions (pointing). Think whether you would add or subtract to get each answer, and put the correct sign in the boxes."

5. HOW MANY MORE ARE NEEDED? Say, "Look at the first box (pointing). How many more marbles would you need to make 3? Yes, 1. Let's add enough marbles in the lower half of this big box(pointing) to make 3 and write the number of marbles we added in this box (pointing). We put 1 marble in the lower half of the big box so we put the number 1 in the little box." "See that the children do it correctly. "Now you must do the next two by yourselves. Look at the next box (pointing). How many more marbles would you need to make 10? Add enough marbles in the lower half of the big box to make 10 and write the number ofmarbles you added in the little box. Now look at the next box (pointing). How many more marbles would you need to make 9? Add enough marbles in the lower half of the big box to make 9 and write the number of marbles you added in the little box."

6. TELLING TIME: Say, "Do you know what time it is by this clock (pointing)? Write the time in this little box (pointing). Look at the next clock (pointing). Read what it says under the clock (pointing). Now draw 2 hands and make this clock say the same time as it says under the clock."

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7. LARGEST AND SMALLEST OF A GROUP OF THREE: Say, "Look at the 3 numbers in this box, (pointing). Draw a ring around the smallest number. Look at the 3 numbers in the next box (Pointing). Draw a ring around the largest number."

8. COUNTING AND WRITING NUMBERS: Say, "Write the missing numbers in the empty spaces, (pointing)."

9. MATCHING WRITTEN FORM WITH PICTORIAL FORM OF GEOMETRIC FIGURES: Say, "Who can read the first word in this box? Yes, it says CIRCLE. Can you find a picture of a circle in this column (pointing)? Yes it is the fourth picture in the column. Let us draw a line from the word CIRCLE to the picture of the circle." See that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves."

10. SELECTION AND APPLICATION OF THE APPROPRIATE PROCESS: Say, "Read, these 2 problems (pointing). Draw a line under the word at the bottom (pointing) that tells what you do to find the answer. Write the answers in the little boxes."

11. KNOWLEDGE OF PLACE VALUE OF ABSTRACT NUMBERS: Say, "Look at the next 2 questions (pointing). Put the correct numbers in the little empty boxes."

<u>Instructions - Part III</u>

Say, "Here are some rather odd looking arithmetic questions. Do you think you can do any of them? See if you can. If you come to some that you can't do, don't worry about them. Just leave those out and keep working down the page to see if you can find any that you can do."

APPENDIX N

PRELIMINARY TEST NUMBER TWO

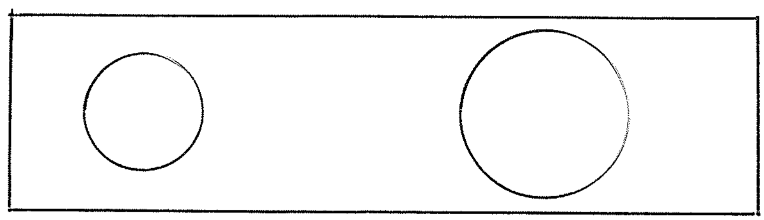
Name................................

Date..............................School.................

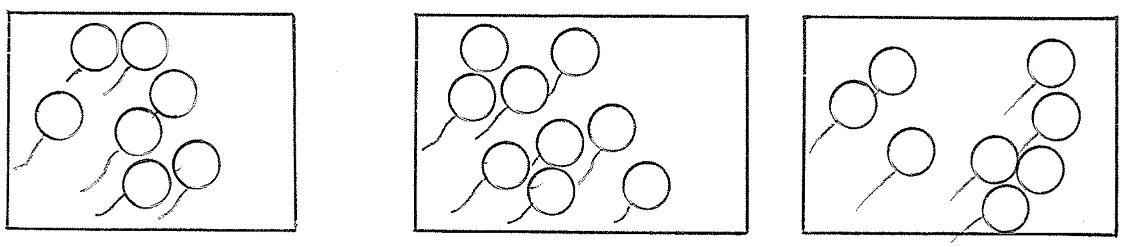
Grade One Arithmetic Part One.

Test of Course Authorized by the Minister of Education, Province of Manitoba, 1953.

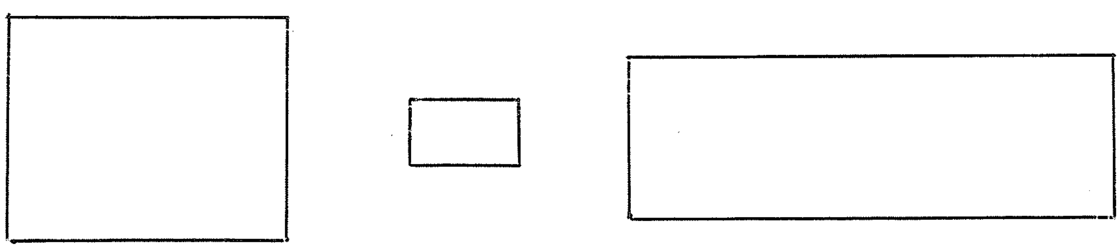
1. Example



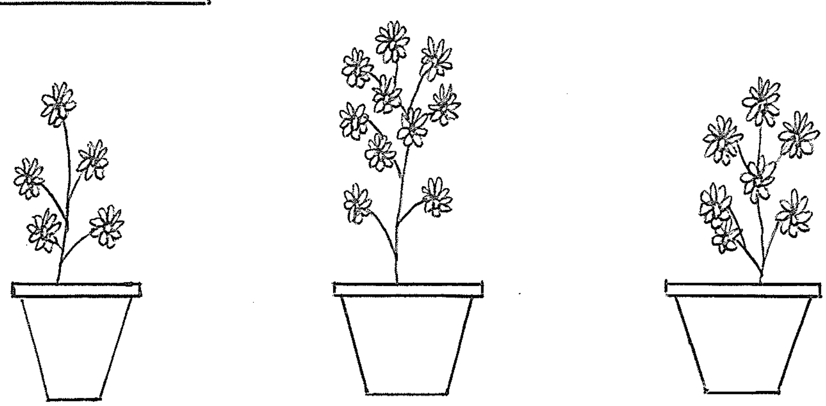
1.(a)



1.(b)



1.(c)



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Example

17

12

1.(d)

46

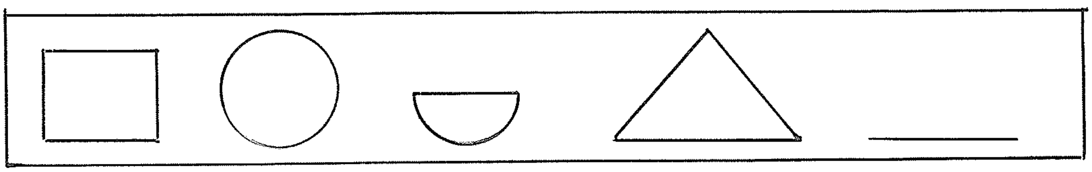
32

1.(e)

59

46

2.

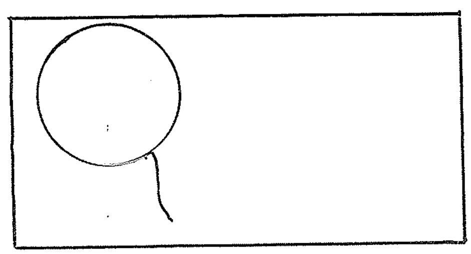


3. Example d.(a) 3.(b) 3.(c)

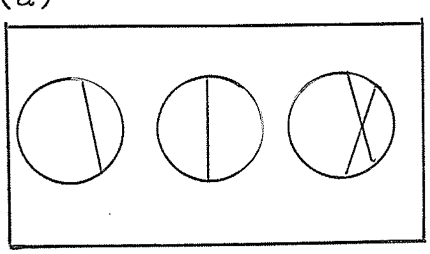
4. (a) (b) (c)

5. (a)

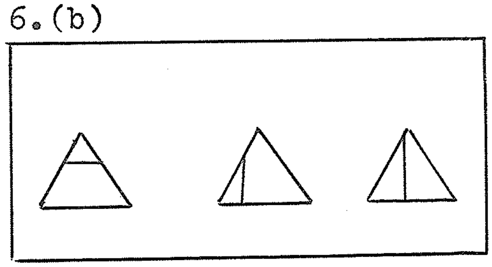
5.(b)



6. (a)



6.(b)



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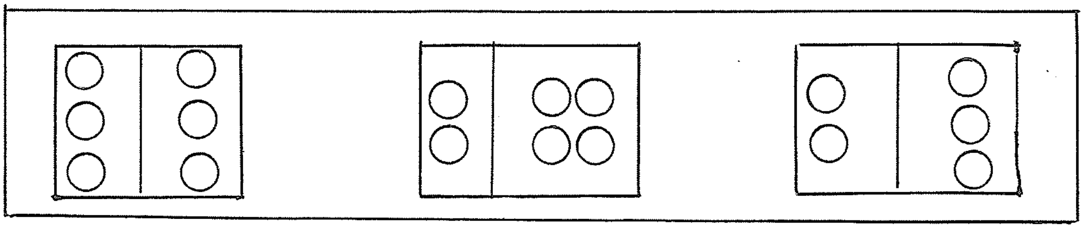
6.(c)

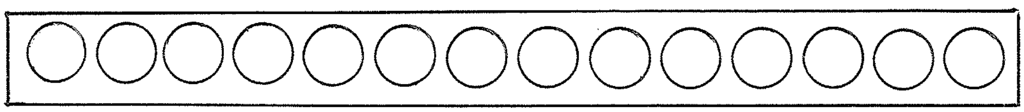


7. Example | 7.(a) | 7.(b)

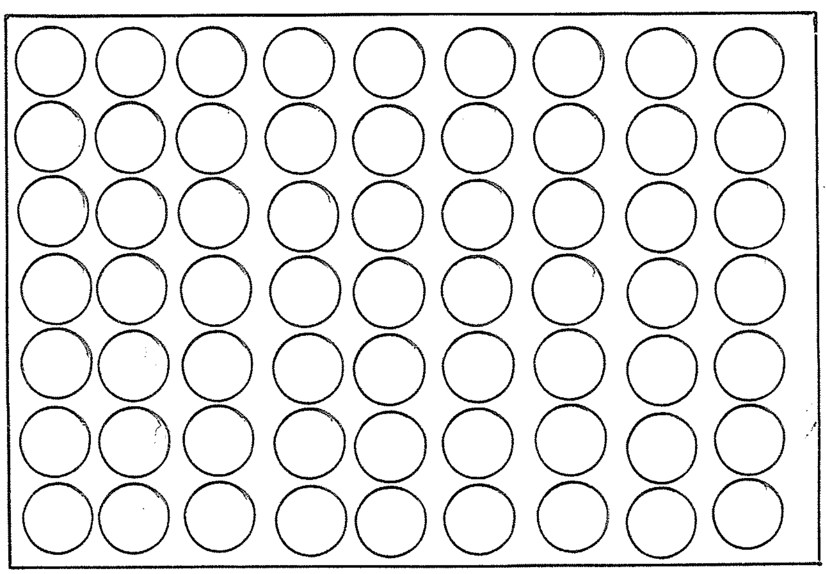
8. a.b.c. | d.e.f. | g.h.i.

a.b.c.	d.e.f.	g.h.i.
7+0=	4+5=	0+8=
3+4=	9-3=	9-5=
5-0=	2+7=	8-6=

9.



10.



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11.

	7 +5	8 +5	9 +7	16 -7	14 -5
a.b.c.d.e.	___	___	___	___	___
	6 +8	17 -9	14 -9	9 +6	13 -9
f.g.h.i.j.	___	___	___	___	___

12.

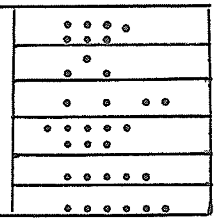
Example	12.(a)	12.(b)	12.(c)
1,2,3	3,4,7	4,4,8	7,9,16

Grade One Arithmetic Part 2.

Test of Content Taught with La Zerte Materials.

1.

a.	Two	3	1.d.	Three	
b.	five	7	e.	Four	
c.	ten	4	f.	Six	
	seven	2		Eight	
		10			



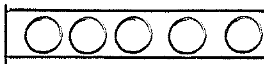
2. a. | 20 | 12 | b. | 71 | 17 | c. | 15 | 50 |

3. a. | 74 | | 76 | b. | | 60 | |

4.a. 5 ☐ 1 = 6 4.b. 8 ☐ 3 = 5

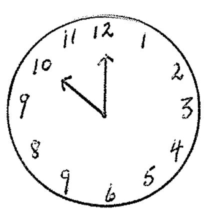
5. Example

5.a.



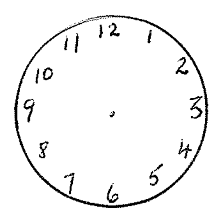
5.b.

6.a.



☐ o'clock

6.b.



5 o'clock

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7.

7	11	4

37	41	29

8\. a. 10, 20, __, __, __, 60

b. 100, 90, 80, __, __, __, 40

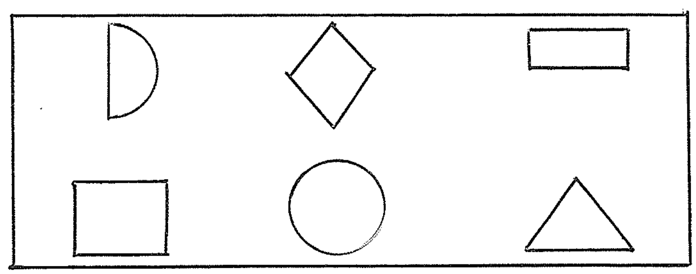
c. 62, 63, __, __, __, 67

d. 5, 10, __, __, __, 30

9\. a. Circle
b.
c. Square

Triangle

Rectangle



10\. a. Jane saw 2 yellow birds.
She saw 4 red birds, too.
How many birds did she see?

Add Subtract Birds

10\. b. There were 13 cookies.
The store man sold 8 cookies
How many were there?

Add Subtract Cookies

11\. a. 72 = tens and ones.

11\. b. 9 tens and 6 ones =

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Grade One Arithmetic Part III.

Test of Content Taught with Cuisenaire Materials.

$3 = \quad\quad + 2$	$5 - (2 + 2) =$
$2 + 1 + \quad = 4$	$1 = 3 -$
$5 - (1 \times 1) =$	$\quad - 2 = 2$
$6 = 1 + \quad\quad + 2$	$3 \times (1 + 1) =$
$2 \times 2 + 2 =$	$1 \times 3 + 1 \times 2 =$

$5 - (2 \times \quad) = 1$	$4 + (\frac{1}{2} \times 2) =$
$6 - (\frac{1}{2} \times \quad) = 4$	$2 + \frac{1}{2} \times 2 + \frac{1}{2} \times 4 =$
$3/2 \times 2 + 2/2 \times 2=$	$2 - (1/3 \times 3) =$
$5/2 \times 2 - 4/3 \times 3 =$	$5 - 4/3 \times 3 + 2 =$
$\frac{1}{2} \times (3 + 1) - \frac{1}{4} (5 - 1) =$	$6 = 2 + 2 \times$

$7 - 2 + \quad\quad = 8$	$8 - \frac{1}{2} \times 4 =$
$1 + 3 + \frac{1}{2} \times 6 + \frac{1}{4} \times 4=$	$1 + 2 + 3 + \quad = 8$
$8 - 3/5 \times 5 =$	$3 \times 3 + \quad\quad = 10$
$9 - \frac{1}{2} \times 4 =$	$\frac{1}{2} \times 10 + 1/5 \times 10 =$

$$1/7 \times (9-2) + 1/8 \times (9 - 1) + 3/5 (9 + 1) =$$

$$10 - \frac{1}{2} \times (7 + 3) = 9 -$$

APPENDIX O

SUMMARY OF ITEM ANALYSIS, PRELIMINARY TEST NUMBER TWO

Item Number	Quartile 4. Number of Correct Responses (25 pupils)	Quartile 3. Number of Correct Responses (25 pupils)	Quartile 2. Number of Correct Responses (25 pupils)	Quartile 1. Number of Correct Responses (25 pupils)	Total Number of Correct Responses	Total Number of Incorrect Responses	Index of Difficulty	Index of Discrimination*
Part One								
1a	25	23	23	18	89	11	89%	G
1b	25	24	22	20	91	9	91%	G
1c	18	17	16	11	62	38	62%	G
1d	20	16	14	8	58	42	58%	G
1e	24	22	23	19	88	12	88%	G
2	21	17	18	20	76	24	76%	G
3a	22	19	17	7	65	35	65%	G
3b	22	19	9	2	52	48	52%	G
3c	21	19	11	1	52	48	52%	G
4a	14	13	7	1	35	65	35%	G
4b	18	12	15	8	53	47	53%	G
4c	19	15	7	10	51	49	51%	G
5a	23	20	17	10	70	30	70%	G
5b	4	10	12	19	45	55	45%	B
6a	25	24	24	22	95	5	95%	G
6b	23	16	18	20	77	23	77%	G

*G (good); B(bad); -(no response)

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
6c	23	19	18	12	72	28	72%	G
7a	21	17	13	4	55	45	55%	G
7b	19	13	5	1	38	62	38%	G
8a	18	11	6	0	35	65	35%	G
8b	24	22	18	1	65	35	65%	G
8c	17	11	4	1	33	67	33%	G
8d	20	17	10	4	51	49	51%	G
8e	19	8	5	2	34	66	34%	G
8f	21	12	9	2	44	56	44%	G
8g	15	10	4	0	29	71	29%	G
8h	17	12	5	2	36	64	36%	G
8i	20	13	4	0	37	63	37%	G
9	14	13	7	2	36	64	36%	G
10	20	14	11	1	46	54	46%	G
11a	25	9	8	0	42	58	42%	G
11b	19	4	4	0	27	73	27%	G
11c	16	5	3	0	24	76	24%	G
11d	9	1	0	1	11	89	11%	G
11e	10	1	0	0	11	89	11%	G
11f	14	3	4	0	21	79	21%	G
11g	4	1	0	0	5	95	5%	G
11h	7	1	0	0	8	92	8%	G
11i	15	5	1	0	21	79	21%	G
11j	7	0	0	1	8	92	8%	G
12a	10	3	3	0	16	84	16%	G
12b	10	8	2	0	20	80	20%	G
12c	4	1	0	0	5	95	5%	G
Part Two								
1a	24	24	21	6	75	25	75%	G
1b	25	20	15	6	66	34	66%	G

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
1c	25	20	17	4	66	34	66%	G
1d	25	25	23	7	80	20	80%	G
1e	24	24	23	3	74	26	74%	G
1f	24	15	16	4	59	41	59%	G
2a	25	25	23	11	84	16	84%	G
2b	19	18	15	6	58	42	58%	G
2c	25	25	20	13	83	17	83%	G
3a	25	19	11	7	62	38	62%	G
$3b_1$	22	13	8	2	45	55	45%	G
3b2	22	19	9	1	51	49	51%	G
4a	25	22	19	8	74	26	74%	G
4b	25	17	12	4	58	42	58%	G
5a	21	20	13	3	57	43	57%	G
5b	23	20	13	1	57	43	57%	G
6a	20	10	10	7	47	53	47%	G
6b	12	8	2	2	24	76	24%	G
7a	25	23	20	10	78	22	78%	G
7b	13	10	4	5	32	68	32%	G
8a	15	6	1	0	22	78	22%	G
8b	10	2	0	0	12	88	12%	G
8c	13	9	3	1	26	74	26%	G
8d	3	0	0	0	3	97	3%	G
9a	15	8	8	7	38	62	38%	G
9b	10	3	1	0	14	86	14%	G
9c	3	1	3	2	9	91	9%	G
$10a_1$	5	4	2	0	11	89	11%	G
$10a_2$	5	3	1	0	9	91	9%	G
$10b_1$	0	0	1	0	1	99	1%	-

APPENDIX O

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	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
$10b_2$	0	0	0	0	0	100	0%	-
11a	0	0	0	0	0	100	0%	-
11b	0	0	0	0	0	100	0%	-
Part Three								
1	0	0	1	0	1	99	1%	-
2	2	0	0	0	2	98	2%	G
3	1	0	1	0	2	98	2%	G
4	0	0	0	0	0	100	0%	-
5	0	1	0	0	1	99	1%	-
6	1	0	0	0	1	99	1%	G
7	0	0	0	0	0	100	0%	-
8	1	0	0	0	1	99	1%	-
9	0	0	0	0	0	100	0%	-
10	0	0	0	0	0	100	0%	-
11	0	0	0	0	0	100	0%	-
12	0	0	0	0	0	100	0%	-
13	0	0	0	0	0	100	0%	-
14	0	0	0	0	0	100	0%	-
15	0	0	0	0	0	100	0%	-
16	0	0	0	0	0	100	0%	-
17	0	0	0	0	0	100	0%	-
18	0	0	0	0	0	100	0%	-
19	0	0	0	0	0	100	0%	-
20	0	0	0	0	0	100	0%	-
21	0	0	0	0	0	100	0%	-
22	0	0	0	0	0	100	0%	-
23	0	0	0	0	0	100	0%	-
24	0	0	0	0	0	100	0%	-
25	0	0	0	0	0	100	0%	-

APPENDIX O

Page 5

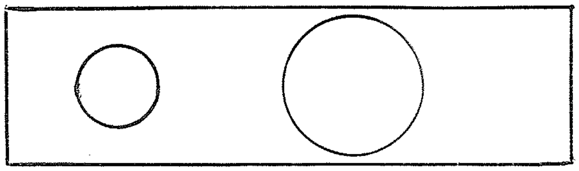
	Q.4.	Q.3.	Q.2.	Q.1.	Corr.	Incorr.	Diff.	Dis.
26	0	0	0	0	0	100	0%	-
27	0	0	0	0	0	100	0%	-
28	0	0	0	0	0	100	0%	-
29	0	0	0	0	0	100	0%	-
30	0	0	0	0	0	100	0%	-

APPENDIX P

THE POWER TEST
GRADE ONE ARITHMETIC
PART ONE

Date.................... School..........................

Example



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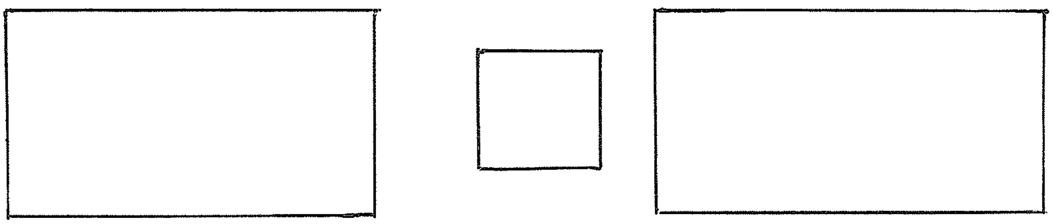
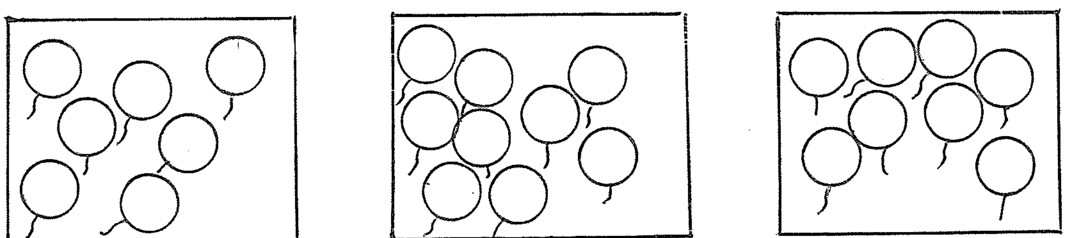
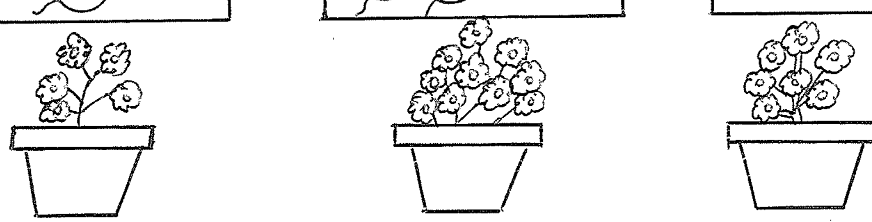


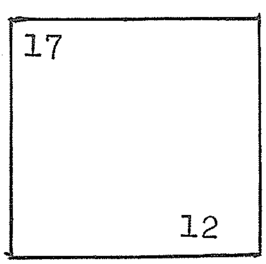
1.b.



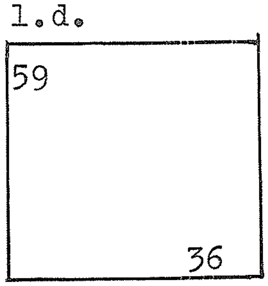
1.c.



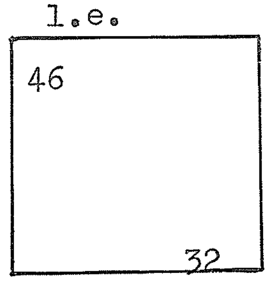
Example



1.d.

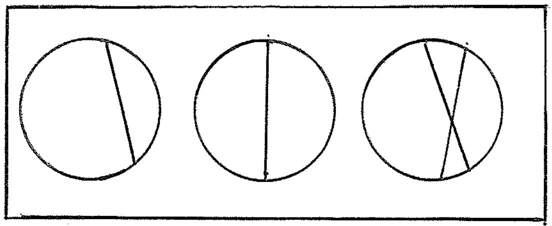


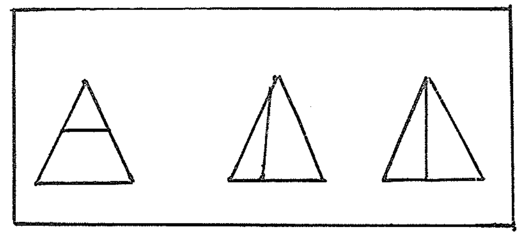
1.e.

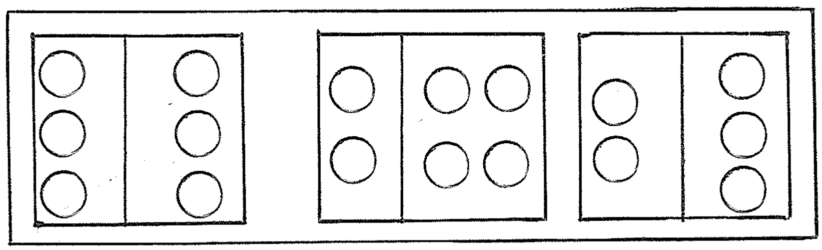


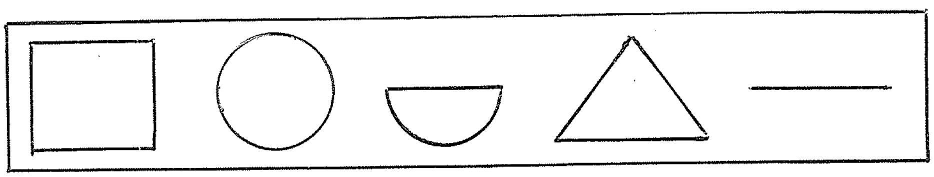
APPENDIX P

Page 2

2.a. 

2.b. 

2.c. 

3. 

4. Example 4a 4b 4c

5. Example 5a 5b 5c

6.

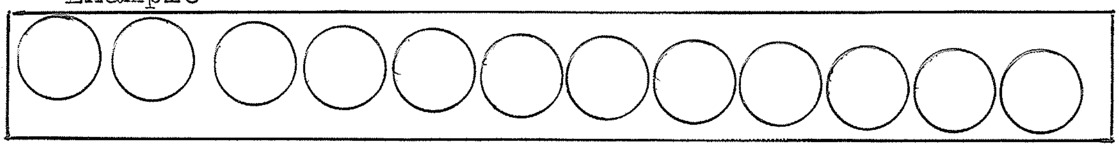
7. Example 7a 7b

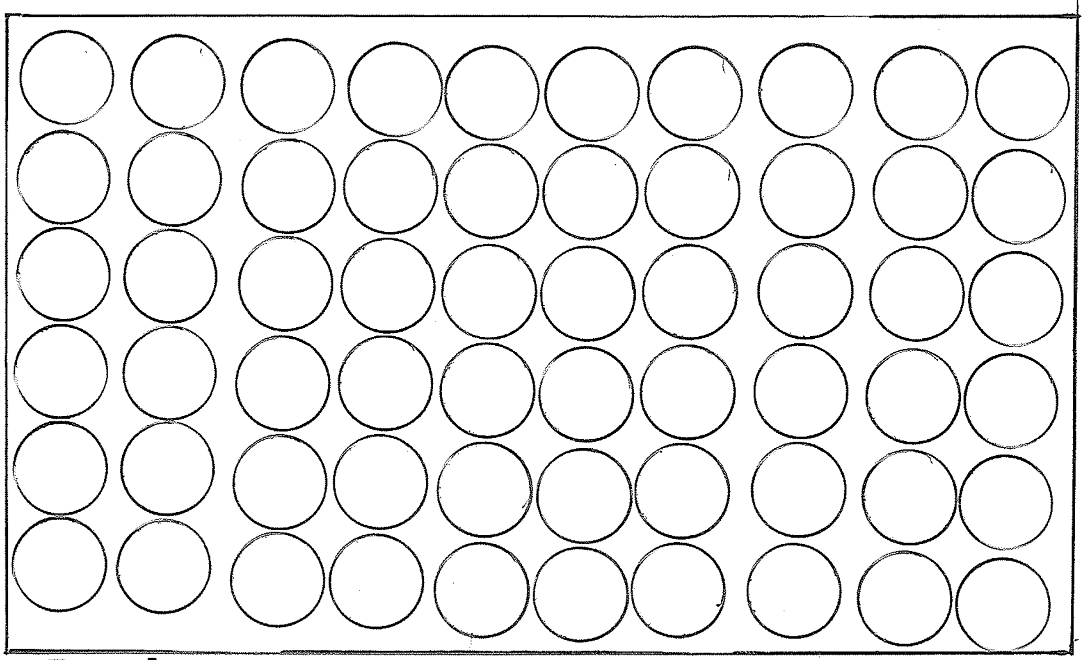
APPENDIX P
Page 3

8.

a.b.c.	d.e.f.	g.h.i.
3+4 =	4 + 5 =	0 + 8 =
5 - 0 =	9 - 3 =	9 - 5 =
7 + 0 =	2 + 8 =	8 - 6 =

Example

9. 



10. Example

APPENDIX P

Page 4

11. a. b. c. d. e.

a.	b.	c.	d.	e.
7	8	9	16	14
+5	+6	+7	-7	-5
___	___	___	___	___

f. g. h. i. j.

f.	g.	h.	i.	j.
6	17	14	9	13
+8	-9	-9	+6	-9
___	___	___	___	___

Example	12a	12b	12c
1,2,3	3,4,7	4,4,8	7,9,16

APPENDIX P
Page 5

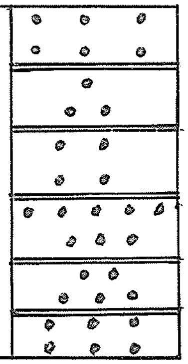
PART TWO

SECTION A

1.

a. b. c.

three	
four	
six	
eight	



d. e. f.

two	7
five	4
ten	2
seven	10
	5
	3

2a. | 20 | 12 |

2b. | 15 | 50 |

2c. | 71 | 17 |

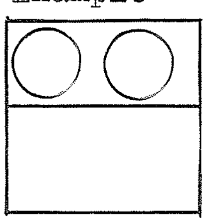
3. a: | 74 | | 76 |

b, c: | | 60 | |

4a 5 ☐ 1=6

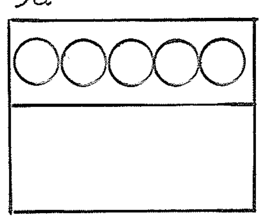
4b 8 ☐ 3=5

5. Example



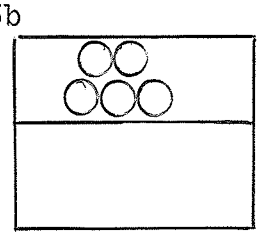
☐

5a



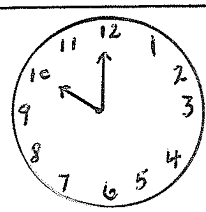
☐

5b



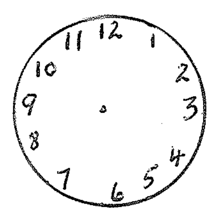
☐

6a



☐ o'clock

6b



5 o'clock

APPENDIX P

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7.

7	11	4

37	41	29

8a. 62, 63, __, __, __, 67

b. 10, 20, __, __, __, 60

c. 100, 90, 80, __, __, __, 40

d. 5, 10, __, __, __, 30.

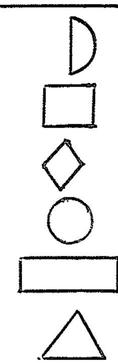
9.

circle

square

triangle

rectangle



10. Jane saw 2 yellow birds.
She saw 4 red birds, too.
How many birds did she see?

☐ birds Add Subtract

11. There were 13 cookies.
The store man sold 8 cookies.
How many were there then?

☐ cookies Add Subtract

12.a. 72 = ☐ tens and ☐ ones.

12.b. 9 tens and 6 ones = ☐

APPENDIX P

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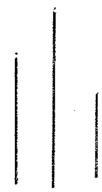
Section B

1a

1b

2.



3.a. ________ cents

3b. ________ cents

4. One dozen = ... eggs.

5. How many 2's are there in 10? ________

6a. 1/2 of 8 = ________

6b. 1/2 of 20 = ________

7a.

$$\begin{array}{r} 2 \\ \times\ 4 \\ \hline \underline{\quad} \end{array}$$

b.

$$\begin{array}{r} 3 \\ \times\ \underline{\quad} \\ \hline 9 \end{array}$$

c.

$$\begin{array}{r} 3 \\ \times 4 \\ \hline \underline{\quad} \end{array}$$

d.

$$\begin{array}{r} 5 \\ \times\ \underline{\quad} \\ \hline 10 \end{array}$$

APPENDIX P

Page 8

Part Three

3 = ... + 2	5 - (2 + 2)=.......
2 + 1 + ...=4	1 = 3 - ....
5 - (1x1) =.....	.......-2 = 2
6 = 1 + ... + 2	3 x (1+1)=.........
2x2+2=.........	1x3+1x2=..........

---

5 - (2 x ....) = 1	4+ (1/2 x 2)=........
6 - (1/2 x ....) = 4	2 + 1/2 x 2 + 1/2 x 4=...
3/2 x 2 + 2/2 x 2=...	2 - (1/3 x 3)=........
5/2 x2-4/3x3=........	5 - 4/3x3+2=........
1/2 x(3+1)-1/4 (5-1)=......	6 = 2+2x.........

---

7 - 2 + ... = 8	8 - 1/2 x 4=.........
1+3+1/2x6+1/4 x 4=.......	1+2+3+......= 8
8 -3/5x 5=.......	3x3+......=10
9-1/2 x 4=.......	1/2 x10+1/5 x10=.....

1/7 x(9-2)+1/8x(9-1)+3/5(9+1)=...............

10 - 1/2 x (7+3)=9-..........

APPENDIX Q

GRADE ONE ARITHMETIC

THE POWER TEST

Instructions for Administering the Test

Before this test is administered, the directions should be understood thoroughly; and during the test they should be followed explicitly.

1. Acquaint yourself with the scope of the test and the instructions for administering it.

2. Fill in the required information concerning each child on the test sheets.

3. Seating is to be arranged so that there will be no opportunity for copying.

4. Each child is to be provided with a sharpened pencil. (A supply of spares should be on hand).

5. In administering the test no instructions to pupils other than those accompanying the test are to be used. If any pupil seems not to understand, simply repeat the instructions.

6. This is not a "timed" test, but when approximately 80% of the group have completed the group of items or have completed all they are able to do of the group of items "without undue haste or unhealthful strain" move on to the next group of items.

7. Give the pupils a "break" of at least five minutes after each fifteen minute working period, so that the factor of fatigue may be reduced to a minimum.

INSTRUCTIONS TO BE GIVEN TO PUPILS WHEN ALL IS READY

INSTRUCTIONS PART ONE

1. COMPARISON: Say, (pointing) "Which ball is bigger? Yes, the second ball. Let us put a mark under the second ball." Teacher demonstrates by putting the example on the blackboard and putting an X under the second ball. She makes sure that the children do it correctly.

APPENDIX Q

Page 2

1a. "Put a mark under the smallest box."

1b. "Put a mark under the box which has the most balloons in it."

1c. "Put a mark under the plant with the fewest flowers on it."

Say, (pointing) "Look at this box. Which is more, 17 or 12? Yes, 17. Let us put a mark under the 17." Teacher sees that the children do it correctly.

1d. "Which is more, 59 or 36? Put a mark under the number that is more."

1e. "Which is less, 46 or 32? Put a mark under the number that is less."

2. FRACTIONS: Teacher puts a figure of a square on the blackboard. She says, "I am going to see if I can draw a line to cut this figure in half." She draws a line which does not cut the figure in half and discusses with the children what is wrong. She tries again and this time cuts the square exactly in half.

2a; 2b; 2c. Say , (pointing) "Look at the figures in these boxes. Put a mark under the figure in each box that shows one half."

3. MEASURES AND GEOMETRIC FIGURES:

Say, "Put a mark under the triangle in the next box, (pointing)."

4. READING AND WRITING NUMBERS:

Say, "Let us write the number 9 in the first box, (pointing)." Teacher sees that the children do it correctly.

4a. "Write the number 97 in the next box."

4b. "Write the number 31 in the next box."

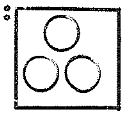
4c. "Write the number 50 in the last box."

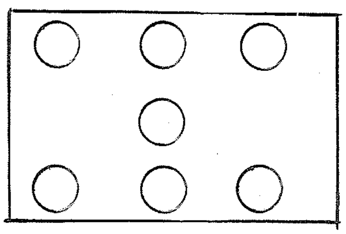
5. FORMING AND RECOGNIZING GROUPS:

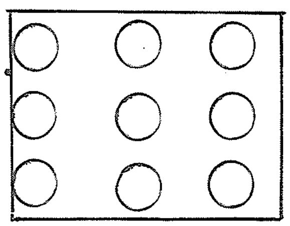
Say, "I am going to show you some cards with some circles on them. I will hold each card up for just a

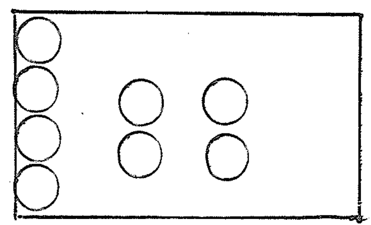
APPENDIX Q

Page 3

few seconds. Watch when I say "Ready". Write the number of circles that you see, in this box, (pointing.") Teacher holds up a manilla 9"x12" card with the following grouping on it:  She checks to see that the children write the number 3 in the first box. She then holds up a manilla 9"x12" card one at a time with the following groupings on them:

5a. 

5b. 

5c. 

She gives the pupils sufficient time to see the form of the patterns but not long enough to count the symbols. The children write the numbers in the proper boxes.

6. VOCABULARY, WORDS RELATING TO SIZE AND POSITION:

Say, "Make a line above this line,(pointing) just as long as this line."

7. ROTE COUNTING TO 100:

Say,"What number comes after 7? Yes, 8. Let us put the number 8 in this box (pointing)." Teacher sees that the children do it correctly.

7a. "What number comes after 36? Put the number in the next box."

7b. "What number comes after 69? Put the number in the last box."

8. ADDITION AND SUBTRACTION:

Say, "There are some addition and some subtraction questions in the next box. Do what the sign says. If you come to one that you can't do, leave it out and go on to the next one. When you have finished all you can do, put your pencils down."

APPENDIX Q

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9. ORDINALS: Say, "Let us put a mark through the eighth ball." Teacher demonstrates on the blackboard how to put an x through the ball, and sees that the children mark the eighth ball correctly. Say "In this big box, (poinging) put a mark through the seventh ball in the fifth row."

10. RATIONAL COUNTING AND ENUMERATION TO 100:

Say, "I am going to rap on the desk with the scissors. I want you to count the number of times I rap." Teacher raps on the desk 4 times. "How many times did I rap? Yes, 4. Let us put the number 4 on this line,(pointing)." Teacher sees that the children do it correctly. "Listen again. Count the number of times I rap and write the number on the next line." Teacher raps 12 times.

11. ADDITION AND SUBTRACTION: (continued)

Say, "There are some addition and some subtraction questions in the next box. Do what the sign says. If you come to one that you can't do, leave it out and go on to the next one. When you have finished all you can do, put your pencils down."

12. TELL THE WHOLE STORY ABOUT:

Say, "Can you tell the whole story about 1, 2 and 3? Let us do it together on the blackboard.

$2 + 1 = 3$
$1 + 2 = 3$
$3 - 1 = 2$
$3 - 2 = 1$

Now we will write the story of 1, 2 and 3 in the first box". Teacher sees that the children do it correctly. "Now you tell the whole story about the numbers under each box. Write the story inside the box."

PART TWO SECTION A

1.a.b.c. MATCHING NUMBER WORD WITH CORRESPONDING NUMBER OF DOTS:

Say, "Look at the first box. What does the first

APPENDIX Q

Page 5

word say? Yes, it says "THREE". Can you find a little box in this column,(pointing) that has 3 dots in it? Let us draw a line from the word THREE to the little box that has 3 dots in it." Teacher sees that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves."

1.d.e.f. MATCHING NUMBER SYMBOL WITH CORRESPONDING NUMBER WORD:

Say,"Let us look at the next box. What does the first word say? Yes, it says "TWO". Can you find the number 2 in this column,(pointing)? Let us draw a line from the word TWO to the number 2." Teacher sees that the children do it correctly. "Now read each of the other words in the box and draw the lines by yourselves."

2. RECOGNITION OF NUMBERS OFTEN CONFUSED:

Say, "There are 2 numbers in each of these 3 boxes (pointing). I will call out one of the numbers in each box and you are to put a circle around the number I call out." Teacher calls out:

a. 20 b. 50 c.17

3. SERIAL ORDER OF NUMBERS:

Say, "In these boxes (pointing) there are some empty spaces,"

a. "In this box (pointing), write the number that comes between these numbers."

b. "In this box(pointing) write the number that comes before this number,(pointing) and the number that comes after this number,(pointing)."

4. SELECTION OF APPROPRIATE PROCESS: Teacher write on the blackboard 2☐1 = 1.

Say, "Did I add or subtract to get the answer? Yes, I subtracted so I will put a subtraction sign in the box." Teacher writes on the blackboard 2☐1 = 3. Say, "Did I add or subtract to get the answer 3? Yes, I added, so I will put an addition sign in the box. Now

APPENDIX Q

Page 6

you look at the next 2 questions (pointing). Think whether you would add or subtract to get each answer, and put the correct sign in the boxes."

5. HOW MANY MORE ARE NEEDED?

Say, "Look at the first box (pointing). How many more marbles would you need to make 3? Yes, 1. Let's add enough marbles in the lower half of this big box (pointing) to make 3 and write the number of marbles we added in this little box (pointing). We put 1 marble in the lower half of the big box so we put the number 1 in the little box." Teacher sees that the children do it correctly. "Now you must do the next two by yourselves. Look at the next box (pointing). How many more marbles would you need to make 10? Add enough marbles in the lower half of the big box to make 10 and write the number of marbles you added in the little box. Now look at the next box (pointing). How many more marbles would you need to make 9? Add enough marbles in the lower half of the big box to make 9 and write the number of marbles you added in the little box."

6. TELLING TIME: Say, "Do you know what time it is by this clock (pointing)? Write the time in this little box (pointing). Look at the next clock (pointing). Read what it says under the clock (pointing). Now draw 2 hands and make this clock say the same time as it says under the clock."

7. LARGEST AND SMALLEST OF A GROUP OF THREE:

Say, "Look at the 3 numbers in this box, (pointing). Draw a ring around the smallest number. Look at the 3 numbers in the next box (pointing). Draw a ring around the largest number."

8. COUNTING AND WRITING NUMBERS:

Say, "Write the missing numbers in the empty spaces, (pointing.)"

9. MATCHING WRITTEN FORM WITH PICTORIAL FORM OF GEOMETRIC FIGURES:

Say, "Who can read the first word in this box? Yes, it says "CIRCLE". Can you find a picture of a circle in this column (pointing)? Yes it is the fourth picture in the column. Let us draw a line from the word CIRCLE to the picture of the circle." See that the children do

APPENDIX Q

Page 7

it correctly. "Now read each of the other words in the box and draw the lines by yourselves."

10 & 11. SELECTION AND APPLICATION OF THE APPROPRIATE PROCESS:

Say, "Read this story, (pointing). Write the answer in this little box,(pointing). When you have written the answer, draw a line under one of these words, (pointing) to tell what you did to find the answer."

Teacher repeats the same instructions for question 11.

12. KNOWLEDGE OF PLACE VALUES OF ABSTRACT NUMBERS:

Say, "Look at the next 2 questions,(pointing). Put the correct numbers in the little empty boxes."

PART TWO SECTION B

1a. Say, "Draw a round shape in this box, (pointing)."

1b. Say, "Draw an oblong shape in this box, (pointing)."

2. Say, "Look at these three lines, (pointing). Put a mark under the line that is the tallest."

3a. Say, "A dime and 6 pennies are how many cents? Put the number on this line, (pointing)."

3b. "Two nickels and 8 pennies are how many cents? Put the number on the next line".

4,5,6,7. Say, "See if you can do the rest of the page by yourselves. When you have done all you can do, put your pencils down."

PART THREE

Say, "Here are some rather odd looking arithmetic questions. Do you think you can do any of them? See if you can. If you come to some that you can't do, don't worry about them. Just leave those out and keep working down the page to see if you can find any that you can do. Write the answers on the dotted lines."

APPENDIX R

Kuhlmann-Anderson Test B

Sixth Edition

NAME ______________________________

GRADE ______________________ BOY_______ GIRL_______

TEACHER ______________________________

SCHOOL ______________________ CITY ______________

DATE TESTED ________ ________ ________
Year Month Day

DATE OF BIRTH ________ ________ ________
Year Month Day

AGE ________ ________ ________
Years Months Days

Test Results ________ ________ ________

Test administered by ______________________

Test scored by ______________________

Comments: ______________________

____

PERSONNEL PRESS, INC. PRINCETON, NEW JERSEY

Test B Summary

M.A.

*. . . . ______
. . . . ______
. . . . ______
. . . . ______
4-8 ______
5-0 ______
5-1 ______
5-2 ______
5-3 ______
5-4 ______
5-5 ______
5-6 ______
5-7 ______
5-8 ______
5-9 ______
5-10 ______
5-11 ______

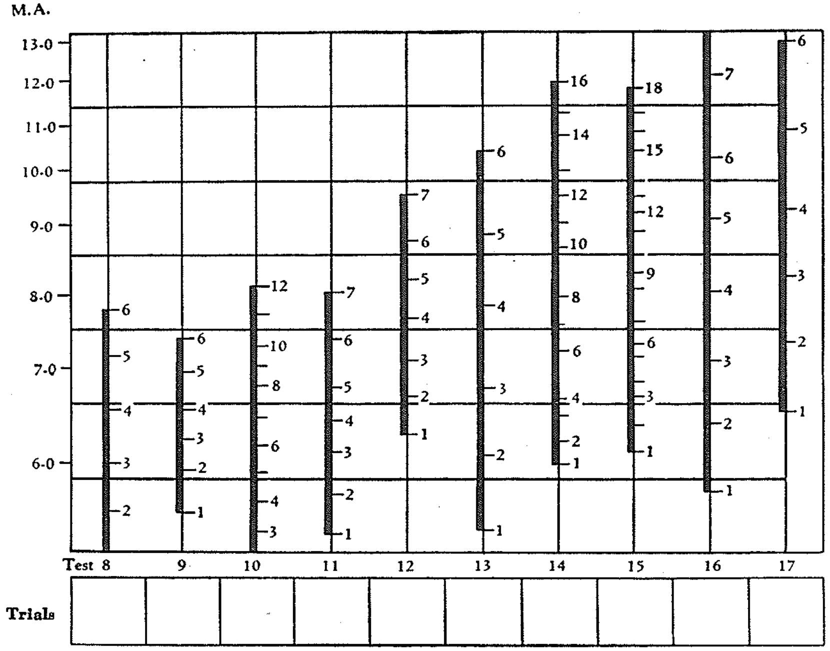
6-0 ______
6-1 ______
6-2 ______
6-3 ______
6-4 ______
6-5 ______
6-6 ______
6-7 ______
6-8 ______
6-9 ______
6-10 ______
6-11 ______
7-0 ______
7-1 ______
7-2 ______
7-3 ______
7-4 ______
7-5 ______
7-6 ______
7-7 ______
7-8 ______
7-9 ______
7-10 ______
7-11 ______

8-0 ______
8-1 ______
8-2 ______
8-3 ______
8-4 ______
8-5 ______
8-6 ______
8-7 ______
8-8 ______
8-9 ______
8-10 ______
8-11 ______
9-0 ______
9-1 ______
9-2 ______
9-3 ______
9-4 ______
9-5 ______
9-6 ______
9-7 ______
9-8 ______
9-9 ______
9-10 ______
9-11 ______

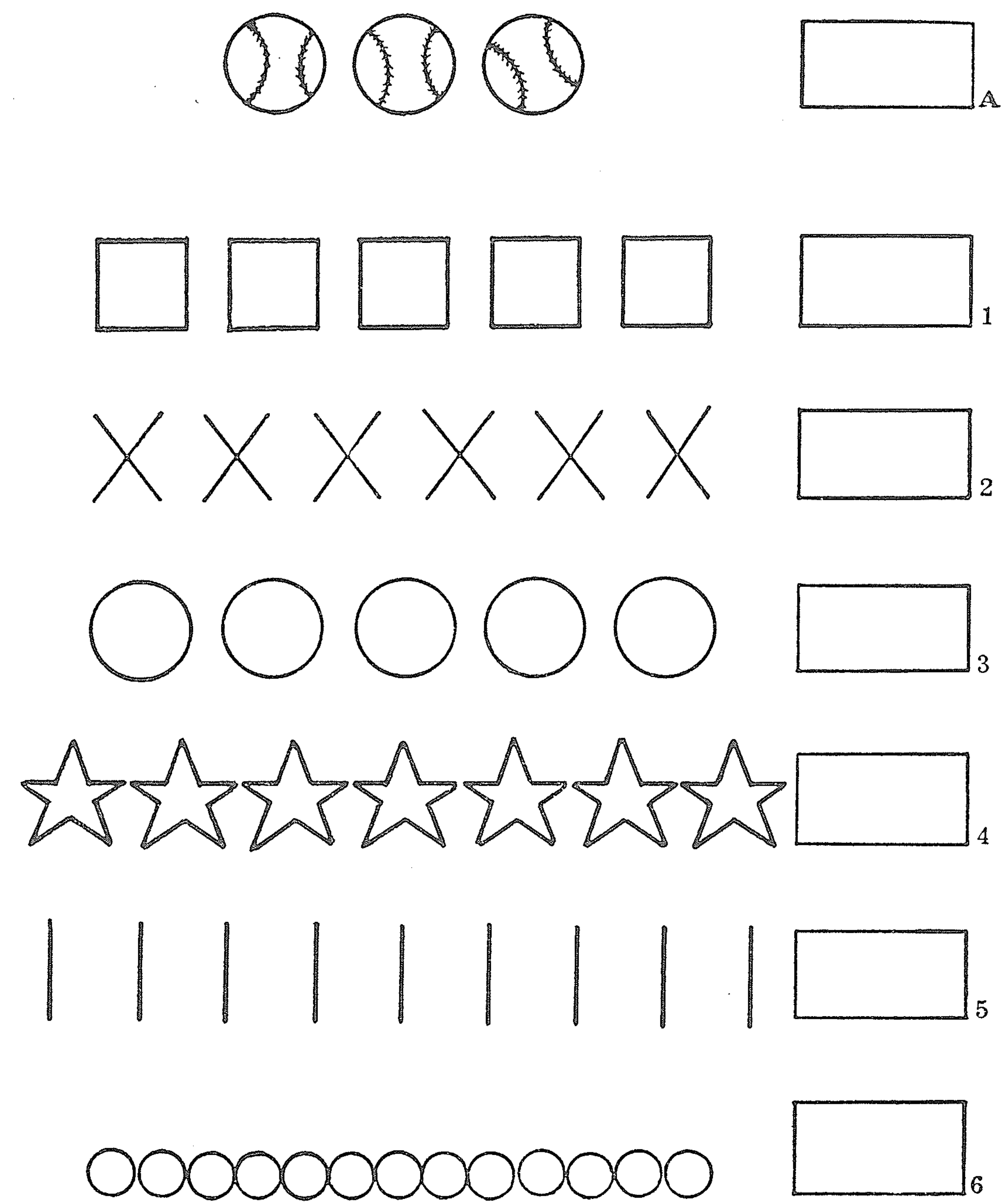
10-0 ______
10-1 ______
10-2 ______
10-3 ______
10-4 ______
10-5 ______
10-6 ______
10-7 ______
10-8 ______
10-9 ______
10-10 ______
10-11 ______
11-1 ______
11-2 ______
11-7 ______
11-10 ______
13-0 ______
13-9 ______

*In these spaces write zero scores and M.A. scores below those listed.
To find the Median M.A. take average of the 5th and 6th highest scores.

Profile of Trials Passed



Median M.A. ______



Test No. 8

A ____

1 ____

2 ____

3 ____

4 ____

5 ____

6 ____

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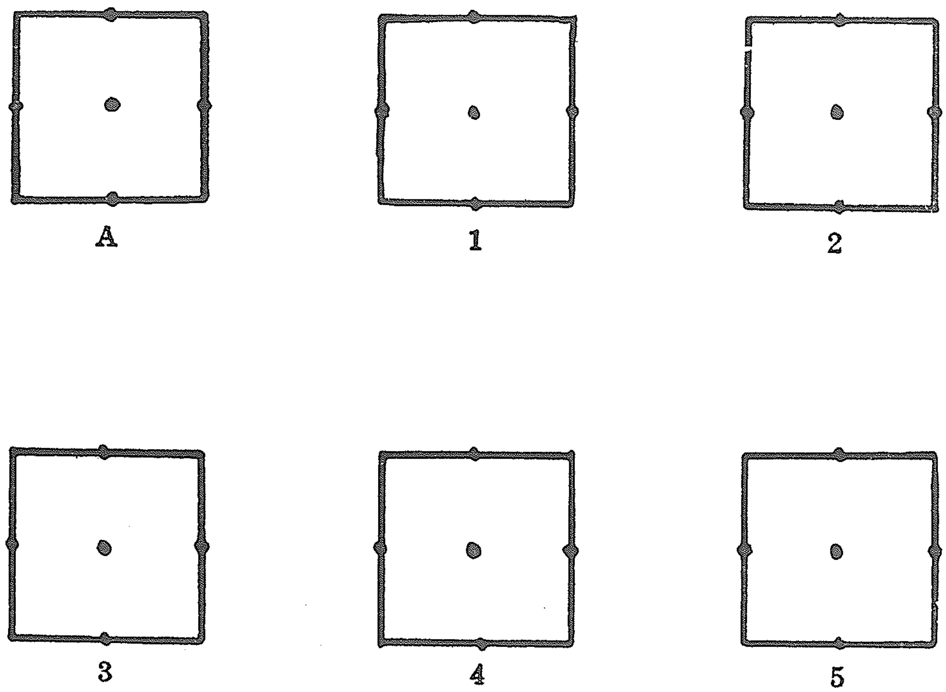

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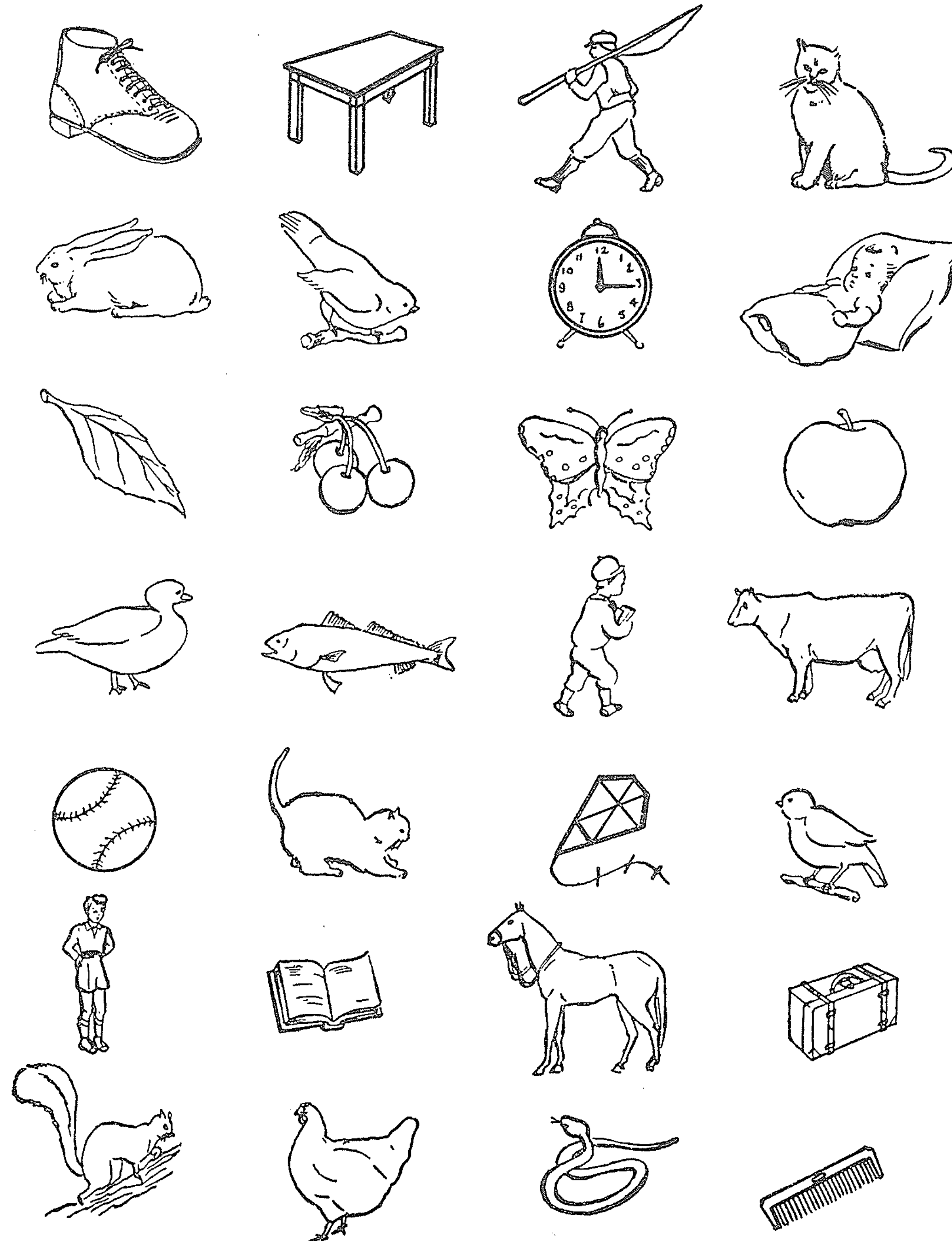

1

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Test No. 11

×	○	×	○	×				
○		○		○				
×		×		×				1
|	—	|	—	|				2
○	×	○	×	○				3
|	×	|	×	|				4
○	—	○	—	○				5
—	○		—	○				6
	×	—		×				7

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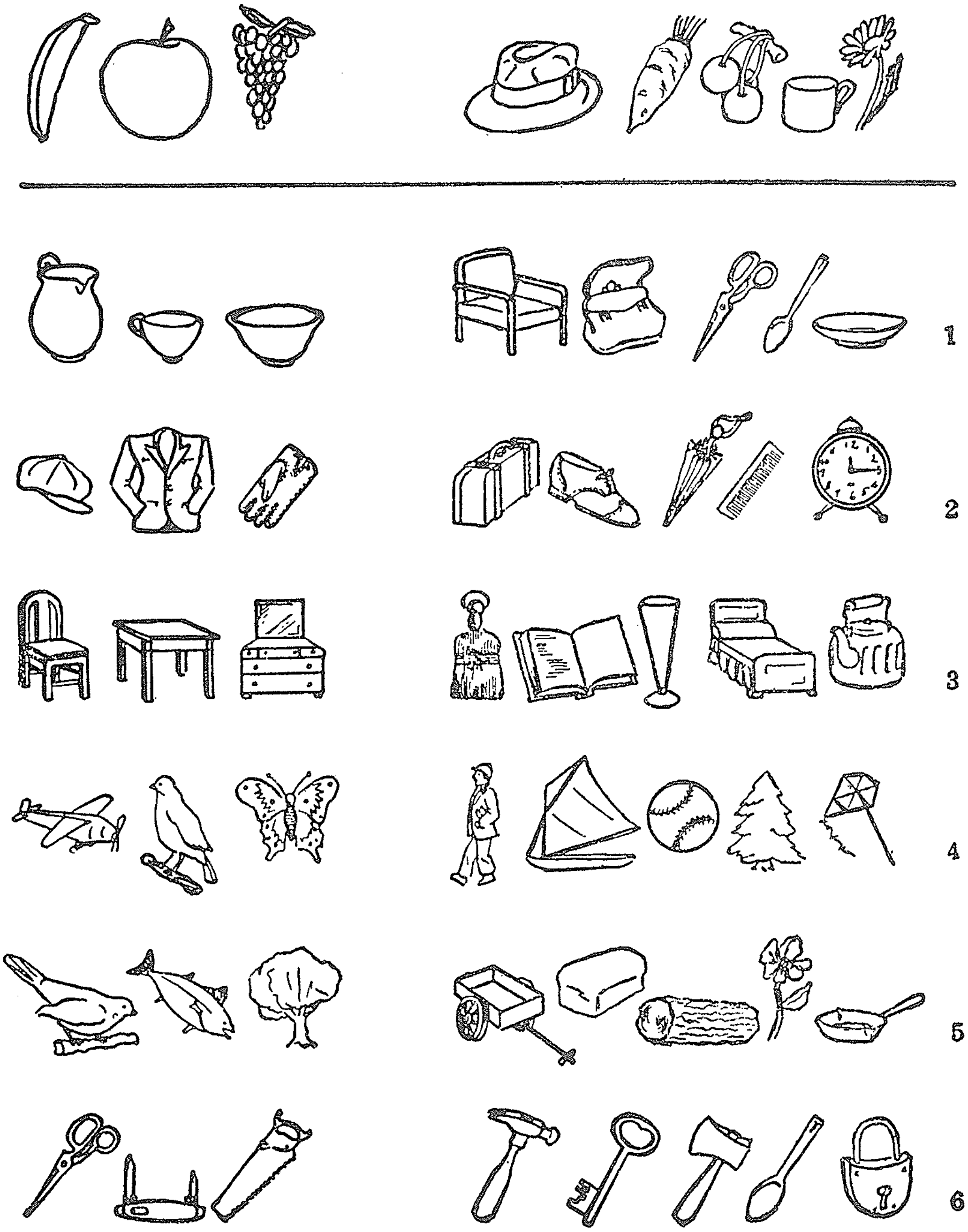

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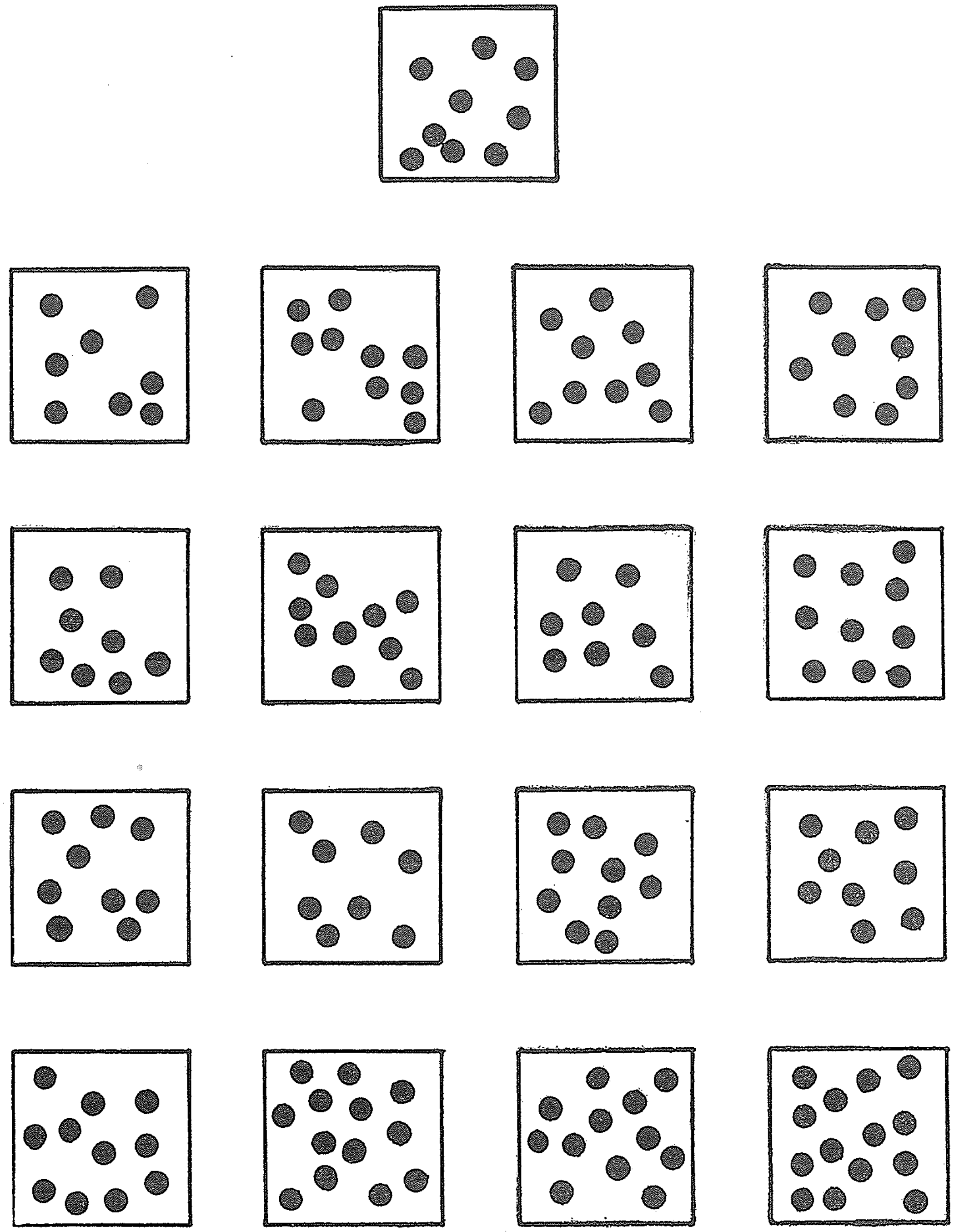

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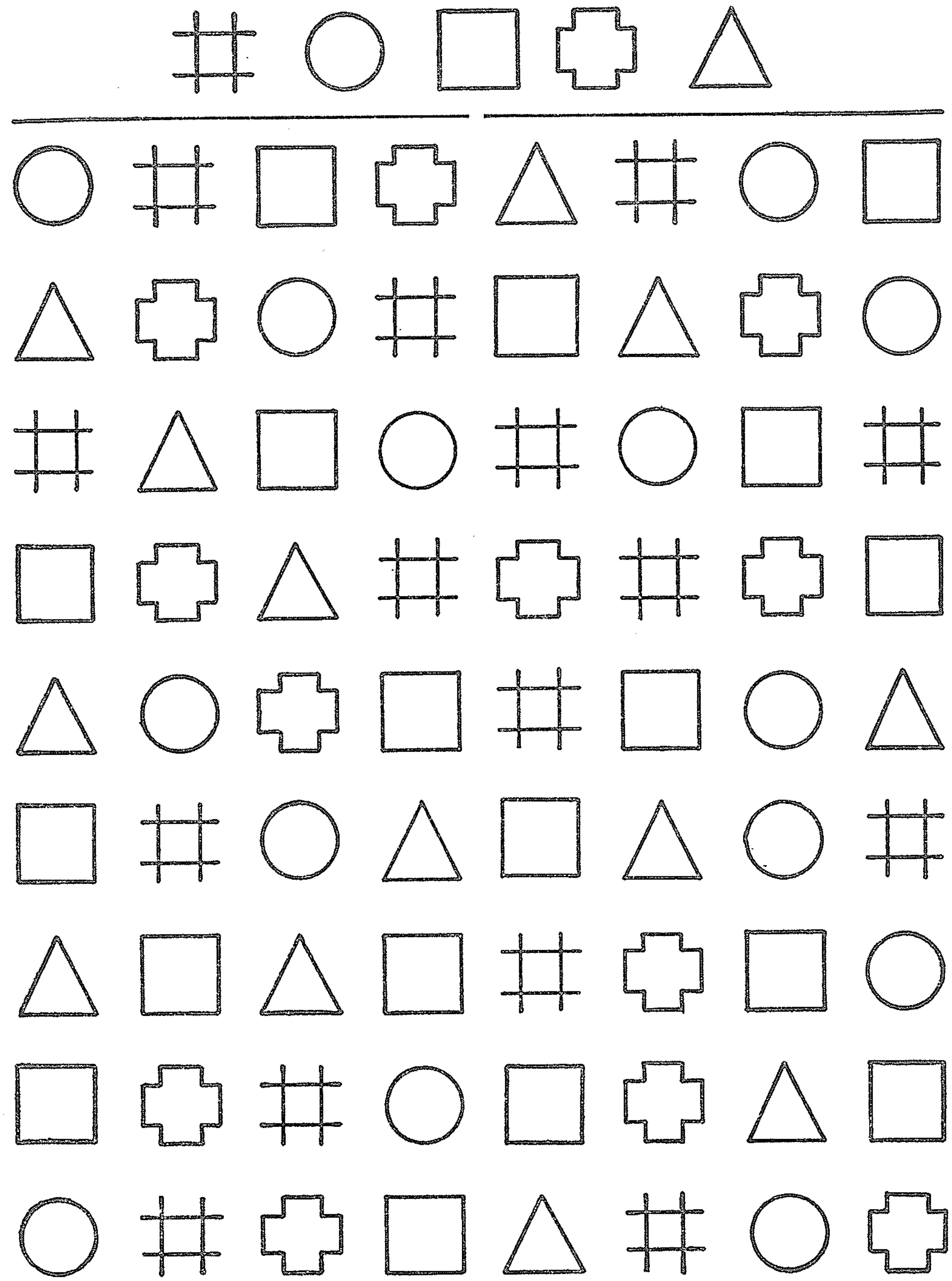

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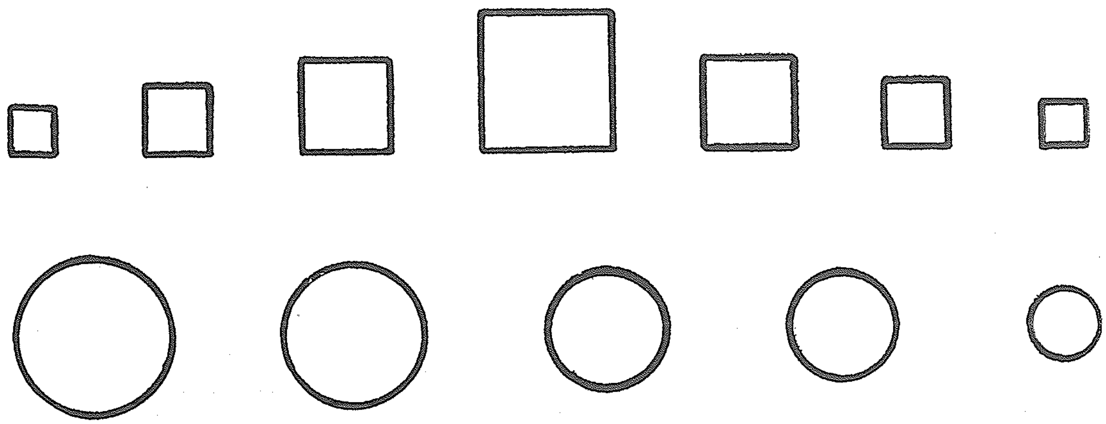

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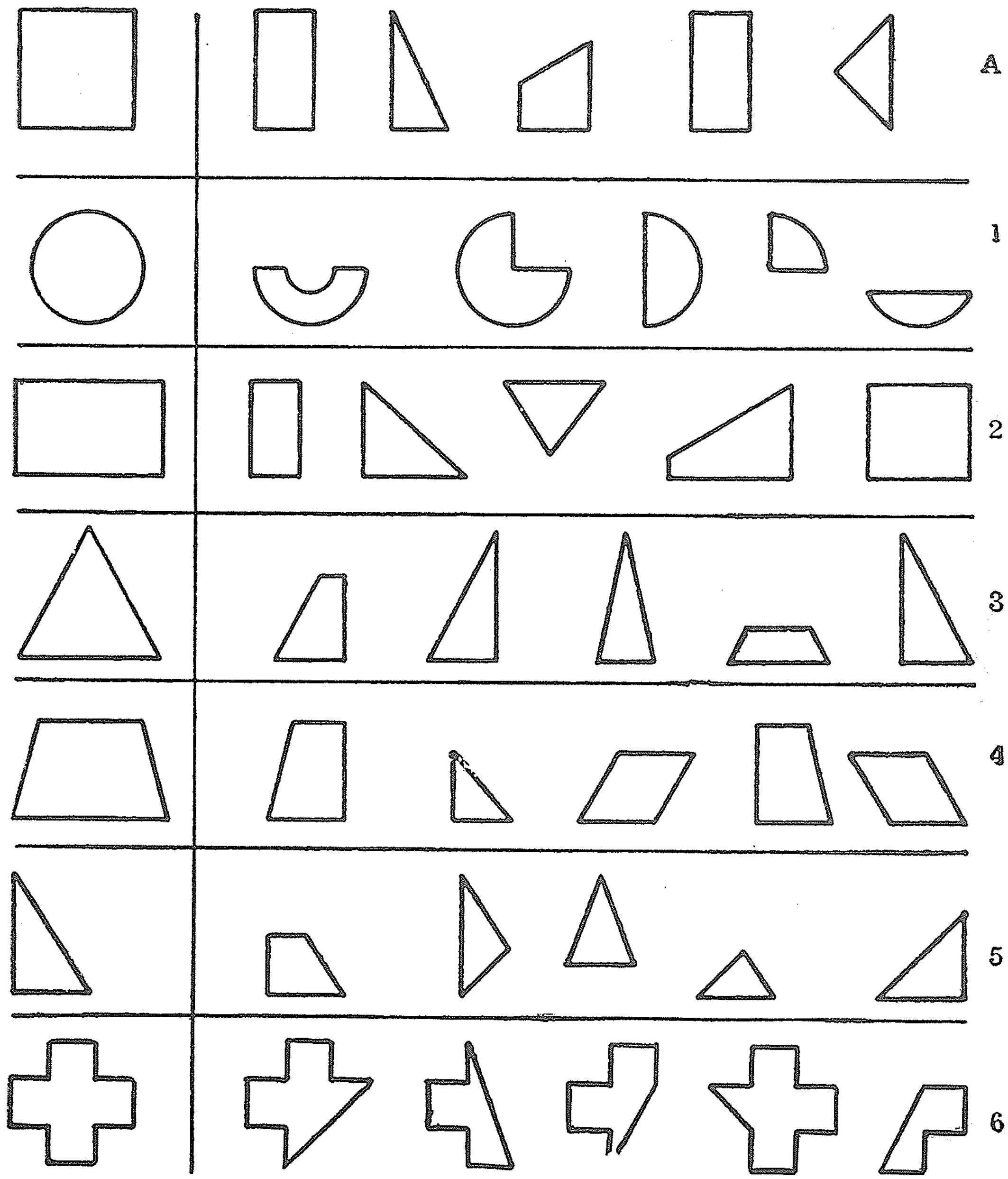

Test No. 17

APPENDIX S

APPENDIX T

Teacher's Name...............

School.......................

<u>Questionnaire to the experimental teachers regarding the effectiveness of the Cuisenaire materials.</u>

1. Do you consider that by using the Cuisenaire materials during the past year you have achieved better results than you probably would have achieved in the same time without the materials?

   YES NO NOT SURE UNABLE TO ANSWER

2. Do you think that with the aid of the Cuisenaire materials, your pupils tended to be less readily frustrated than formerly?

   YES NO NOT SURE UNABLE TO ANSWER

3. Schonell states, "Most of the difficulty in arithmetic arises because we hurry children too much in the early stages."[1] Do you consider that with the aid of the Cuisenaire materials it was possible to proceed firmly and quickly during the early stages, and to do so with safety?

   YES NO NOT SURE UNABLE TO ANSWER

4. Would you predict that for a substantial number of pupils:

   (a) skill in addition may be more quickly and easily developed with than without the Cuisenaire materials?

   YES NO NOT SURE UNABLE TO ANSWER

---

1. Fred J. Schonell and F. Eleanor Schonell, <u>Diagnosis and Remedial Teaching in Arithmetic</u> (Edinburgh: Oliver and Boyd, 1957), p.12.

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(b) skill in subtraction may be more quickly and easily developed with than without the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

(c) multiplication tables may be more effectively mastered in a shorter period of time with than without the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

5. Did you experience any difficulty in weaning your pupils away from using the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

6. Although you were asked to limit the time spent on teaching arithmetic to twenty minutes per day during the experiment, did you feel inclined to devote more time than this to arithmetic?

YES NO NOT SURE UNABLE TO ANSWER

7. How many periods or parts of periods did you allow at the outset, for unaided exploration with the Cuisenaire materials?

8. If you were to teach the Cuisenaire method to Grade One another year, how many periods or parts of periods would you set aside for exploration?

9. Did you find it was generally better to give time for exploration at the beginning or at the end of the period? Why?

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10. Did you teach the fact that rods of the same colour are also of the same length, or did you wait until the children discovered the fact for themselves?

11. Approximately how long did it take your pupils to learn to link colour and length (the unstained rod taken as unit)?

12. Please give examples of one or two of the more striking "discoveries" that the children made for themselves.

13. When using the Cuisenaire materials, do you think that working in groups assisted the learning process? Why?

14. What do you think is the optimum size of group?

15. What do you think is the best sort of grouping? (e.g. sexes separate, dull children with bright children, etc)? Why?

16. When using the Cuisenaire materials was there any evidence of a different rate of learning between the sexes? If so, which way?

17. Did the materials appeal more to the one sex than to the other? If so, to which one?

APPENDIX T

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18. What "crutches" did you allow?

19. Were you able to gain information by observing a child working with the rods that you might not have obtained otherwise?

20. When did you begin to teach fractions?

21. How did you teach the concept of zero?

22. Do you foresee any difficulties to which use of the Cuisenaire materials may later give rise?

23. Will you please give any other information about your use of the Cuisenaire materials that you think may be of interest.

24. From your own experience do you feel that the children you have taught by the Cuisenaire method enjoyed arithmetic more than the children you have taught by other methods? If so, to what do you attribute this enjoyment?

25. Did you enjoy instructing with the Cuisenaire materials to the extent that you would like to continue to use them for another year?

APPENDIX U

August 31, 1960

Miss L.A. Corben,
Greenway School,
850 St. Matthews Avenue,
Winnipeg 10, Manitoba.

Dear Miss Corben:

May I take this opportunity of thanking you for your cooperation and assistance with our Cuisenaire experiment during the past year. As a final request, we are asking that you read the enclosed questionnaire, and with last year's class in mind, consider each question very carefully before answering it.

This questionnaire is an extremely important part of the experiment. It is our only means of recording your subjective reactions to the Cuisenaire method of teaching arithmetic.

In questions 1 to 6 inclusive would you please encircle the appropriate reply, and in the space provided below each question, add any pertinent comments. Keeping in mind your class of last year please try to answer questions 7 to 25 in the light of your actual experience with the Cuisenaire method.

When you have completed the questionnaire kindly return it to the office not later than September 17.

Yours sincerely,

A.D. Thomson,
Assistant Superintendent.

ADT/cb

Enclosure

APPENDIX V

Name.....................

School...................

Questionnaire to the Principals, Vice-Principals and Primary Supervisors regarding the effectiveness of the Cuisenaire materials.

1. Do you consider that by using the Cuisenaire materials during the past year, better results were achieved than probably would have been achieved in the same time without the materials?

YES NO NOT SURE UNABLE TO ANSWER

2. Do you think that with the aid of the Cuisenaire materials, the pupils tended to be less readily frustrated than formerly?

YES NO NOT SURE UNABLE TO ANSWER

3. Schonell states, "Most of the difficulty in arithmetic arises because we hurry children too much in the early stages."[1] Do you consider that with the aid of the Cuisenaire materials it was possible to proceed firmly and quickly during the early stages, and to do so with safety?

YES NO NOT SURE UNABLE TO ANSWER

4. Would you predict that for a substantial number of pupils:

(a) skill in addition may be more quickly and easily developed with than without the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

1. Fred J. Schonell and F. Eleanor Schonell, Diagnosis and Remedial Teaching in Arithmetic (Edinburgh: Oliver and Boyd, 1957), p.12.

(b) skill in subtraction may be more quickly and easily developed with than without the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

(c) multiplication tables may be more effectively mastered in a shorter period of time with than without the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

5. Do you think that the teachers in the experiment experienced difficulty in weaning their pupils away from using the Cuisenaire materials?

YES NO NOT SURE UNABLE TO ANSWER

6. Although the teachers were asked to limit the time spent on teaching arithmetic to twenty minutes per day during the experiment, do you think the experimental teachers were inclinded to devote more time than this to arithmetic? If so, why?

YES NO NOT SURE UNABLE TO ANSWER

7. Did you witness any striking "discoveries" that the children made for themselves?

8. When using the Cuisenaire materials, do you think that working in groups assisted the learning process? Why?

APPENDIX V

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9. What do you think is the optimum size of group?

10. What do you think is the best sort of grouping? (e.g. sexes separate, dull children with bright children, etc.)? Why?

11. As you witnessed the children working with the Cuisenaire materials, was there any evidence of a different rate of learning between the sexes? If so, which way?

12. Did the materials seem to appeal more to the one sex than to the other? If so, to which one?

13. Were you able to gain information by observing a child working with the rods that you might not have obtained otherwise?

14. Do you foresee any difficulties to which use of the Cuisenaire materials may later give rise?

15. Will you please give any other information about your use of the Cuisenaire materials that you think may be of interest?

APPENDIX V

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16. Do you think that the children you observed being taught by the Cuisenaire method enjoyed arithmetic more than those you observed being taught by the Jolly Numbers method? If so, to what do you attribute this additional enjoyment?

17. From your observations last year would you like to see additional classes taught by the Cuisenaire method this year?

APPENDIX W

September 2, 1960

Mr. A.J. Ryckman, Principal,
King Edward School,
1416 Arlington Street,
Winnipeg 4, Manitoba

Dear Mr. Ryckman,:

May I take this opportunity of thanking you for your cooperation and assistance with our Cuisenaire experiment during the past year. As a final request we are asking that you read the enclosed questionnaire, and with your observations of last year's experimental classes in mind, consider each question very carefully before answering it.

This questionnaire is an extremely important part of the experiment. It is our only means of recording your subjective reactions to the Cuisenaire method of teaching arithmetic.

In questions I to VI inclusive, would you please encircle the appropriate reply, and in the space provided below each question, add any pertinent comments. Please try to answer questions 7 to 17 in the light of your actual observations.

When you have completed the questionnaire, kindly return it to the office not later than September 17.

Yours sincerely,

A.D. Thomson,
Assistant Superintendent

IH/dm
enc.

APPENDIX X

RESULTS OF ALL PUPILS PRESENT FOR COMPLETE TESTING PROGRAMME

Experimental Group #2		Scores										
			Power Test (March)				Power Test (June)					
Name of Pupil	Date of Birth	Arithmetic Readiness Test	Part I	Part II	Part III	Total	Part I	Part II	Part III	Total	Intelligence Quotient
Pupil #1	25/5/53	14	20	25	10	55	28	31	15	74	105
#2	24/11/53	14	26	22	14	62	33	32	18	83	117
#3	3/11/53	16	32	27	8	67	33	34	20	87	139
#4	27/6/53	14	29	23	10	62	23	32	11	66	109
#5	26/6/53	16	27	22	7	56	27	21	3	51	112
#6	11/6/53	16	25	25	6	56	26	28	4	58	107
#7	12/5/53	15	29	26	11	66	32	27	14	73	103
#8	27/5/53	15	16	19	7	42	30	31	12	73	105
#9	26/11/53	14	32	28	8	68	35	35	11	81	129
#10	6/6/53	9	13	18	8	39	29	30	6	65	107
#11	27/8/53	13	19	18	5	42	24	23	3	50	112
#12	2/2/53	14	15	12	9	36	27	20	5	52	105
#13	16/10/53	15	19	19	7	45	19	19	6	44	115
#14	6/11/53	15	14	11	3	28	25	21	5	51	109
#15	3/5/53	15	20	22	8	50	23	25	10	58	106
#16	19/3/53	16	23	20	9	52	31	31	12	74	104
#17	1/5/53	15	26	30	8	64	33	30	11	74	107
#18	24/10/53	15	27	23	9	59	33	27	10	70	115
#19	10/10/53	16	20	18	5	43	28	20	9	57	110
#20	30/8/53	15	17	15	3	35	28	22	6	56	109
#21	9/8/53	16	37	35	18	90	38	40	28	106	122
#22	19/8/53	14	20	12	6	38	27	27	7	61	100
#23	1/11/53	14	25	28	13	66	34	33	22	89	118
#24	22/11/53	14	33	20	11	64	35	35	18	88	122
#25	23/8/53	13	13	5	6	24	22	19	5	46	114
#26	6/4/53	15	15	22	4	41	23	29	2	54	109

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Experimental Group #3		Scores										
			Power Test (March)				Power Test (June)					
Name of Pupil	Date of Birth	ART.	P.I	P.II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil #27	30/10/53	14	20	26	2	48	30	32	15	77	119
#28	7/5/53	16	15	10	8	33	26	26	12	64	107
#29	27/10/52	12	18	27	5	50	27	34	9	70	109
#30	7/9/53	16	31	26	10	67	35	33	9	77	117
#31	17/5/53	16	24	20	3	47	21	26	2	49	106
#32	9/6/53	16	29	24	5	58	26	33	6	65	113
#33	29/7/53	12	25	22	1	48	22	26	2	50	112
#34	6/6/53	15	29	29	12	70	35	39	20	94	114
#35	10/10/53	10	17	19	7	43	26	27	5	58	101
#36	20/10/53	13	17	21	0	38	18	23	4	45	119
#37	3/3/53	16	30	30	9	69	37	43	19	99	124
#38	9/10/53	11	13	13	2	28	21	23	4	48	103
#39	18/2/53	13	27	32	12	71	26	36	12	74	107
#40	18/7/53	15	31	28	7	66	33	35	8	76	113
#41	9/6/53	15	20	16	3	39	22	22	2	46	111
#42	19/10/52	10	9	13	4	26	22	21	4	47	97
#43	12/2/53	16	31	32	10	73	37	38	18	93	109
#44	6/4/53	14	13	20	4	37	27	24	5	56	98
#45	4/8/53	14	27	25	2	54	33	38	8	79	95
#46	20/1/53	12	12	22	2	36	18	19	1	38	99
#47	21/9/53	14	37	30	8	75	33	40	18	91	116
#48	18/6/52	13	26	23	5	54	32	23	1	56	89
#49	31/7/53	16	15	21	2	38	26	33	7	66	110
#50	2/2/53	14	13	17	2	32	25	30	9	64	107
Experimental Group #4											
#51	21/5/53	15	30	36	14	80	42	42	27	111	117
#52	4/8/53	16	36	28	8	72	35	41	21	97	114
#53	11/6/53	14	34	32	10	76	30	41	23	94	114
#54	22/9/53	16	34	40	19	93	41	44	27	112	120
#55	6/4/53	16	35	29	5	69	38	36	14	88	116

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Experimental Group #4		Scores										
			Power Test (March)				Power Test (June)					
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil #56	30/5/53	16	39	44	14	97	41	41	27	109	116
#57	9/4/53	16	35	28	13	76	40	37	26	103	114
#58	14/9/53	12	33	22	4	59	29	30	12	71	117
#59	12/7/53	16	39	41	18	98	40	43	29	112	118
#60	27/6/53	16	33	27	7	67	36	37	10	83	110
#61	16/11/53	14	31	28	11	70	39	40	24	103	126
#62	21/5/53	15	31	26	9	66	39	42	20	101	114
#63	25/11/51	12	31	31	10	72	33	36	21	90	99
#64	28/10/53	13	31	29	7	67	41	36	28	105	122
#65	7/6/53	15	26	22	4	52	39	38	13	90	113
#66	9/12/52	16	40	38	12	90	41	41	27	109	105
#67	16/3/53	15	32	33	16	81	37	41	25	103	114
#68	22/1/53	16	41	41	19	101	40	43	26	109	113
#69	13/5/53	15	33	42	18	93	34	44	23	101	117
#70	2/4/53	13	30	25	6	61	32	35	19	86	106
#71	19/12/52	13	28	31	7	66	32	34	12	78	109
#72	12/5/53	15	35	33	9	77	37	44	22	103	115
Experimental Group #5											
#73	22/5/53	10	28	30	6	64	41	42	26	109	114
#74	26/1/53	14	36	22	7	65	35	33	16	84	108
#75	23/5/53	13	28	12	4	44	32	25	8	65	108
#76	27/8/53	13	26	20	6	52	30	32	12	74	112
#77	22/5/53	12	31	33	13	77	36	39	19	94	121
#78	11/4/53	10	26	26	9	61	32	28	14	74	105
#79	2/12/53	13	22	16	1	39	31	29	16	76	121
#80	24/12/52	14	30	19	0	49	38	36	9	83	120
#81	4/1/53	14	36	32	20	88	41	44	22	107	119
#82	21/9/53	14	27	15	1	43	32	36	8	76	121
#83	10/4/53	16	35	30	19	84	35	39	8	82	115
#84	7/1/53	16	34	27	7	68	36	38	16	90	117
#85	25/12/52	13	30	23	6	59	34	35	13	82	108

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Name of Pupil	Date of Birth	ART	Power Test (March) P.I	P. II	P. III	T.	Power Test (June) P.I	P. II	P. III	T.	I.Q
Experimental Group #5											
Pupil #86	16/2/53	14	36	34	9	79	38	41	22	101	115
#87	8/2/53	16	29	25	9	63	28	33	18	79	106
#88	4/9/53	15	32	26	6	64	39	38	22	99	121
#89	12/4/53	10	23	11	5	39	31	27	18	76	105
#90	14/5/53	15	40	34	9	83	41	35	26	102	118
#91	19/1/53	10	21	18	3	42	33	23	4	60	111
#92	3/10/53	16	28	21	3	52	37	35	14	86	107
#93	6/10/53	12	36	33	15	84	35	40	9	84	120
#94	9/5/53	16	38	28	14	80	40	42	22	104	105
#95	14/4/53	16	31	28	8	67	38	34	17	89	120
#96	8/8/53	14	38	33	12	83	40	39	21	100	119
#97	4/3/53	15	34	38	19	91	41	44	26	111	117
#98	16/3/53	14	24	17	11	52	32	26	23	81	113
#99	11/12/52	16	24	19	2	45	37	30	11	78	106
#100	23/11/53	15	29	22	8	59	36	32	13	81	114
#101	10/1/53	15	42	41	25	108	41	45	27	113	119
Experimental Group #6											
#102	30/4/53	15	24	23	6	53	27	26	11	64	118
#103	15/10/53	15	28	29	4	61	28	39	12	79	117
#104	10/5/53	16	32	29	13	74	36	37	17	90	122
#105	6/5/53	15	32	26	10	68	32	36	21	89	117
#106	11/2/53	16	33	30	5	68	35	41	19	95	115
#107	18/12/52	15	29	27	14	60	34	35	20	89	105
#108	30/3/53	16	35	28	13	76	42	37	18	95	104
#109	2/6/53	15	29	25	12	66	34	38	20	92	116
#110	26/6/53	16	25	20	8	53	27	34	16	77	117
#111	11/7/52	16	27	24	3	54	30	33	11	74	101
#112	21/1/53	16	27	27	12	66	37	36	18	91	112
#113	23/12/52	16	39	34	12	85	32	38	19	89	114
#114	31/3/53	16	30	28	9	67	40	40	22	102	113
#115	9/4/53	16	38	39	13	90	36	40	21	97	118

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Experimental Group #6		Scores										
			Power Test (March)				Power Test (June)					
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil											
#116	5/11/53	15	26	25	13	64	29	33	13	75	126
#117	9/9/53	16	26	31	13	70	32	39	23	94	124
#118	3/1/53	16	33	30	15	78	36	40	24	100	114
#119	23/12/52	16	35	33	11	79	38	38	22	98	112
#120	2/12/52	16	36	28	5	69	41	39	18	98	112
#121	7/5/53	16	24	21	6	51	25	25	11	61	114
#122	31/3/53	15	24	22	7	53	31	30	9	70	107
#123	5/9/53	16	29	25	10	64	30	38	19	87	113
#124	2/11/53	15	23	25	2	50	32	39	14	85	114
#125	29/10/53	16	21	23	2	46	23	38	3	64	109
#126	18/4/53	16	31	32	13	76	41	42	24	107	117
#127	11/7/53	16	34	28	16	78	37	35	18	90	113
Experimental Group #7											
#128	13/5/53	16	37	31	16	84	33	38	19	90	111
#129	7/3/53	16	29	33	8	70	33	41	10	84	114
#130	21/8/53	15	24	26	12	62	30	28	11	69	108
#131	18/8/53	14	16	12	1	29	18	12	4	34	111
#132	12/5/53	14	21	27	6	54	32	34	19	85	113
#133	2/8/53	12	21	22	8	51	22	33	8	63	114
#134	9/3/53	14	15	21	3	39	32	26	9	67	116
#135	14/7/53	16	28	21	5	54	25	37	8	70	112
#136	25/9/53	14	33	31	7	71	33	38	14	85	117
#137	28/4/53	15	34	25	8	67	39	36	17	92	114
#138	11/2/53	15	25	24	8	57	32	26	7	65	100
#139	18/8/53	15	38	40	25	103	34	43	28	105	138
#140	19/6/53	14	19	22	13	54	28	27	20	75	107
#141	17/12/52	14	26	23	4	53	31	34	13	78	100
#142	20/12/52	15	39	41	13	93	34	43	26	103	107
#143	9/12/53	16	34	33	23	90	40	43	25	108	109
#144	10/12/52	16	32	36	16	84	33	42	26	101	115
#145	12/5/53	16	29	25	4	58	32	35	5	72	117

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Experimental Group #7

Name of Pupil	Date of Birth	ART	Power Test (March) P.I	P. II	P. III	T.	Power Test (June) P.I	P. II	P. III	T.	I.Q.
Pupil											
#146	4/1/53	16	36	33	14	83	35	43	21	99	101
#147	3/1/53	15	26	23	6	55	31	35	12	78	102
#148	12/8/53	14	30	27	9	66	33	35	14	82	107
#149	23/10/53	15	16	16	1	33	19	18	4	41	116
#150	6/7/53	15	36	30	14	80	36	34	17	87	120
#151	16/8/53	16	18	20	4	42	25	31	14	70	124
#152	15/8/53	16	28	32	19	79	28	35	24	87	119
#153	9/5/53	15	34	35	16	85	35	39	26	100	114
Experimental Group #8											
#154	24/1/53	14	31	34	27	92	39	38	26	103	107
#155	20/5/53	16	31	37	20	88	40	41	27	108	114
#156	17/12/52	15	36	33	25	94	38	40	29	107	110
#157	25/1/53	14	31	27	19	77	38	36	30	104	111
#158	22/6/53	15	36	33	24	93	39	43	28	110	112
#159	4/5/53	16	28	35	20	83	32	41	25	98	109
#160	11/7/53	14	29	28	18	75	26	32	26	84	120
#161	22/9/53	16	28	30	9	67	29	34	16	79	122
#162	1/7/53	15	32	38	20	90	36	41	28	105	119
#163	6/7/53	16	39	36	26	101	36	40	29	105	123
#164	28/5/53	14	34	34	19	87	35	41	25	101	115
#165	17/3/53	16	26	24	5	55	38	34	27	99	110
#166	19/4/53	16	36	32	25	93	39	39	26	104	116
#167	7/8/53	16	33	36	22	91	36	41	27	104	123
#168	5/3/53	16	36	40	25	101	41	45	30	116	107
#169	9/6/53	16	36	34	25	95	40	40	30	110	115
#170	15/1/53	15	35	39	27	101	40	41	29	110	108
#171	4/7/53	15	36	33	22	91	41	38	25	104	114
#172	18/1/53	15	32	39	17	88	39	36	25	100	114
#173	7/4/53	15	28	34	19	81	41	42	28	111	95
Experimental Group #9											
#174	27/1/53	12	25	26	18	69	29	34	10	73	108
#175	12/7/53	13	27	29	17	73	30	38	20	88	123

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Experimental Group #9		Scores										
			Power Test (March)				Power Test (June)					
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil											
#176	3/2/53	12	21	14	12	47	25	23	14	62	103
#177	24/9/53	15	28	22	14	64	32	34	21	87	123
#178	7/5/53	15	22	8	7	37	13	19	5	37	105
#179	7/4/52	16	31	21	12	64	28	34	2	64	91
#180	28/8/53	16	31	22	9	62	37	37	13	87	121
#181	29/4/53	12	27	24	22	73	29	38	27	94	118
#182	26/5/53	12	24	23	17	64	30	37	16	83	118
#183	8/8/52	15	29	31	12	72	34	36	15	85	99
#184	18/6/53	15	23	27	17	67	33	37	17	87	113
#185	7/6/53	14	28	23	9	60	32	38	21	91	116
#186	3/8/53	12	23	27	13	63	27	32	14	73	121
#187	4/7/53	16	21	15	20	56	35	32	18	85	112
#188	14/11/53	13	22	18	14	54	31	31	19	81	114
#189	14/11/53	12	22	19	11	52	27	34	12	73	114
#190	12/6/53	12	25	15	6	46	29	26	12	67	105
#191	16/12/52	13	26	21	7	54	31	33	9	73	106
#192	18/1/52	14	23	16	10	49	24	27	13	64	91
Experimental Group #10											
#193	26/9/53	14	28	17	9	54	33	32	15	80	116
#194	11/6/53	15	29	28	5	62	35	38	10	83	116
#195	12/5/53	13	24	24	5	53	37	34	6	77	115
#196	13/8/53	9	19	15	0	34	28	21	21	70	108
#197	16/9/53	13	19	22	5	46	21	25	8	54	119
#198	18/8/53	12	25	31	10	66	31	39	17	87	114
#199	16/8/53	13	29	33	8	70	32	40	21	93	118
#200	2/11/53	9	26	27	9	62	31	37	16	84	125
#201	19/5/53	10	12	15	0	27	26	19	4	49	101
#202	19/9/53	13	32	27	5	64	38	37	17	92	114
#203	2/7/53	11	8	2	5	15	10	8	1	19	92
#204	10/11/53	14	33	25	14	72	35	31	16	82	118
#205	29/11/53	16	27	31	3	61	35	41	14	90	121

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Experimental Group #10		Scores									
			Power Test (March)				Power Test (June)				
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil											
#206	1/1/53	15	27	22	9	58	25	25	12	62	104
#207	23/9/53	15	27	24	5	56	31	33	11	75	110
#208	22/10/53	15	18	20	3	41	23	23	3	49	115
#209	25/8/53	16	24	30	5	59	30	41	7	78	118
#210	22/10/53	11	10	9	3	22	17	15	1	33	98
Experimental Group #11											
#211	30/9/52	16	27	32	11	70	36	39	23	98	103
#212	23/3/53	12	9	14	3	26	26	19	10	55	107
#213	26/6/53	15	30	21	6	57	36	25	8	69	116
#214	4/6/53	16	17	15	4	36	30	24	11	65	113
#215	12/6/53	13	20	24	4	48	27	30	12	69	110
#216	1/4/53	15	21	14	0	35	25	16	5	46	97
#217	21/1/53	16	30	21	6	57	32	32	23	87	124
#218	9/9/52	16	18	13	3	34	29	25	14	68	100
#219	16/10/53	16	18	21	8	47	32	32	7	71	108
#220	27/6/53	13	13	13	0	26	19	18	5	42	108
#221	24/7/53	12	13	12	5	30	22	15	3	40	105
#222	16/9/53	15	28	24	6	58	35	31	21	87	106
#223	5/3/53	15	16	24	7	47	29	31	9	69	116
#224	9/5/53	16	21	20	0	41	29	31	14	74	104
#225	9/2/53	12	23	16	6	45	22	21	3	46	106
#226	25/5/53	11	11	16	2	29	18	22	4	44	104
#227	18/4/53	12	5	18	1	24	35	22	6	63	104
#228	14/3/53	15	16	18	2	36	33	31	8	72	110
#229	18/3/53	14	32	31	6	69	38	35	21	94	110
#230	15/12/52	11	11	15	2	28	25	15	4	44	100
Control Group #2											
#231	14/3/53	15	35	25	4	64	36	33	5	74	113
#232	26/12/52	14	31	22	1	54	36	25	2	63	103
#233	5/12/52	16	30	28	3	61	34	35	4	73	107
#234	30/3/53	15	37	27	4	68	34	26	3	73	110
#235	13/11/53	14	33	29	3	65	39	33	8	80	120

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Control Group #2

Name of Pupil	Date of Birth	ART	Power Test (March) P.I	P. II	P. III	T.	Power Test (June) P.I	P. II	P. III	T.	I.Q.
Pupil											
#236	17/7/53	16	33	34	3	70	39	37	4	80	120
#237	29/12/52	16	32	26	2	60	31	26	3	60	101
#238	28/7/53	16	37	28	0	65	34	36	2	72	119
#239	3/6/53	14	34	30	3	67	33	32	4	69	113
#240	14/3/53	16	33	35	3	71	33	27	5	75	115
#241	16/7/53	16	35	21	2	58	26	29	2	67	119
#242	25/2/53	16	31	27	4	62	34	31	6	71	114
#243	9/2/53	16	33	25	2	60	34	33	6	73	113
#244	2/5/53	16	29	20	1	50	34	27	2	63	113
Control Group #3											
#245	8/5/53	14	24	16	1	41	18	20	2	40	114
#246	1/3/53	16	29	20	2	51	36	31	2	69	110
#247	18/9/53	15	30	19	3	52	27	24	3	54	114
#248	23/1/53	16	31	20	0	51	34	31	6	71	108
#249	6/9/53	15	19	17	4	40	27	24	3	54	112
#250	16/4/53	16	37	34	5	76	36	35	5	76	116
#251	6/10/53	14	34	32	4	60	37	29	7	73	110
#252	22/4/53	14	21	18	1	40	25	20	3	48	113
#253	30/9/53	14	18	17	0	35	28	24	0	52	119
#254	16/6/53	15	22	17	2	41	26	23	2	51	118
Control Group #4											
#255	21/6/53	14	30	24	4	58	28	32	2	62	104
#256	30/8/53	13	20	12	4	36	21	23	4	48	110
#257	25/7/53	16	37	35	8	80	31	33	1	65	114
#258	16/3/53	15	33	30	5	68	36	32	2	70	104
#259	4/10/53	16	21	20	2	43	21	18	2	41	119
#260	21/6/53	16	30	28	4	62	29	30	3	62	117
#261	21/6/53	16	36	31	7	74	29	38	6	73	118
#262	11/5/53	14	25	24	5	54	25	27	3	55	95
#263	6/6/53	15	30	26	1	57	31	28	1	60	111
#264	13/3/53	14	29	23	2	54	28	31	3	62	103
#265	28/2/53	16	32	26	4	62	35	33	4	72	113

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Control Group #4		Scores									
			Power Test (March)				Power Test (June)				
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil											
#266	18/8/53	12	28	26	2	56	23	33	0	56	110
#267	7/7/53	16	33	27	3	63	34	31	2	67	112
#268	10/9/53	13	40	31	11	82	36	34	9	79	119
#269	19/1/53	11	34	28	6	68	33	30	1	64	93
#270	31/3/53	13	35	25	4	64	31	28	3	62	104
#271	10/8/53	15	33	27	2	62	31	31	2	64	116
#272	25/2/53	16	31	23	4	58	31	26	3	60	97
#273	16/5/53	16	22	24	3	49	32	27	2	61	109
#274	15/12/52	12	22	21	1	44	22	22	2	46	94
#275	8/5/53	15	32	23	4	59	30	28	1	59	115
#276	10/7/53	14	33	28	4	65	29	33	5	67	110
Control Group #5											
#277	17/1/53	16	34	31	0	65	34	34	0	68	114
#278	27/3/53	16	35	28	2	65	36	35	4	75	115
#279	19/3/53	13	25	23	0	48	38	24	0	62	114
#280	1/6/53	15	26	29	2	57	27	35	0	62	114
#281	11/10/53	12	26	22	2	50	36	27	2	65	123
#282	4/9/53	15	36	28	3	67	38	36	2	76	124
#283	7/9/53	15	24	19	1	44	30	25	0	55	121
#284	6/6/53	15	24	26	1	51	35	34	0	69	112
#285	30/7/53	13	29	23	1	53	31	30	3	64	118
#286	13/3/53	16	32	25	4	61	31	27	0	58	112
#287	5/3/53	16	33	24	4	61	37	30	5	72	115
#288	22/1/53	16	34	29	0	63	36	39	0	75	108
#289	15/2/53	15	30	24	4	58	32	32	2	66	119
#290	7/5/53	15	33	26	1	60	34	28	2	64	117
#291	21/5/53	13	24	21	6	51	36	27	2	65	116
#292	18/6/53	16	34	37	5	76	38	35	5	78	121
#293	21/8/53	16	31	26	0	57	31	31	1	63	114
#294	1/9/53	13	27	18	2	47	30	23	0	53	121

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Control Group #6

Name of Pupil	Date of Birth	ART	Power Test (March) P.I	P. II	P. III	T.	Power Test (June) P.I	P. II	P. III	T.	I.Q.
Pupil											
#295	4/9/53	15	32	33	3	68	40	38	5	83	116
#296	26/4/53	16	37	36	0	73	35	35	4	74	133
#297	14/8/53	15	28	19	2	49	29	25	1	55	107
#298	16/12/52	15	34	34	2	70	33	40	5	78	120
#299	16/11/53	16	27	21	1	49	27	26	3	56	125
#300	12/4/53	15	33	29	0	62	35	34	8	77	113
#301	26/2/53	16	28	25	0	53	31	30	2	63	115
#302	9/12/52	13	32	25	1	58	25	19	1	45	109
#303	12/11/53	12	27	27	2	56	31	38	3	72	126
#304	15/7/53	15	27	25	0	52	29	30	3	62	115
#305	6/4/53	16	32	30	1	63	37	34	5	76	109
#306	10/9/52	16	24	23	0	47	30	24	1	55	120
#307	26/9/53	15	28	27	0	55	30	33	3	66	120
#308	14/7/53	15	31	31	0	62	30	35	4	69	112
#309	20/5/53	16	31	28	4	63	30	25	3	58	123
#310	28/1/53	15	27	26	0	53	29	34	7	70	114
#311	7/4/53	16	25	20	3	48	28	32	5	65	115
#312	3/2/53	15	20	13	0	33	23	20	4	47	112
#313	12/12/52	16	29	28	3	60	27	33	7	67	112
#314	2/11/53	15	29	16	0	45	31	26	0	57	123
#315	23/4/53	16	29	29	0	58	34	31	2	67	114
#316	1/8/53	16	32	31	3	66	38	37	4	79	115
#317	2/12/52	16	20	25	0	45	27	27	0	54	104
#318	19/3/53	9	29	24	5	58	28	26	6	50	113
#319	26/1/53	11	19	13	1	33	29	23	3	55	103
#320	15/5/53	16	33	29	1	63	33	38	8	79	116
#321	6/6/53	16	31	33	1	65	33	39	6	78	116
#322	2/8/53	15	28	22	1	51	29	36	3	68	115
#323	11/3/53	15	19	25	0	44	27	26	2	55	111
Control Group #7											
#324	26/7/53	16	25	25	2	52	30	33	1	64	117

DIRECTIONS

for Administering and Scoring

KUHLMANN-ANDERSON
TEST B

Published by
PERSONNEL PRESS, INC.
Princeton, New Jersey

CONTENTS

RANGES OF KUHLMANN-ANDERSON BOOKLETS

Booklet	*Approx. grade*	*Tests*	*Age where tests fit best*[1]	*Maximum M.A. for booklet*	*Corresponding maximum I.Q. for C.A. best fit*
K	Kdgn.	(1-10)	5-8	7-5	131
A	1	(4-13)	6-1	7-9	127
B	2	(8-17)	7-3	9-11	137
C	3	(12-21)	8-4	12-5	149
D	4	(15-24)	9-4	14-4	154
E	5	(19-28)	10-7	16-3	154
F	6	(22-31)	11-9	18-10	160
G	7-8	(25-34)	13-2	24-5[3]	185[3]
H	9-12	(30-39)	16-0[2]	31-3[3]	200[3]

[1]Based upon median M.A. for half of trials passed in each test.
[2]C.A. 15-6 maximum used in computing I.Q.
[3]See Master Manual, "Interpretation of adult-age scores."

SELECTION OF BOOKLETS

The booklet to be used in testing any particular group of pupils is determined by the expected average mental level of the group. If not enough is known about the probable average mental level, it should be assumed that the average mental age is about the same as the average chronological age of the group. Battery K is recommended for use in the latter months of kindergarten; battery A is usually best suited to the early months of grade 1; battery B, early in grade 2, etc. (In the latter months of grade 1, battery B is usually to be preferred; in the latter months of grade 2, battery C, etc.). See the Complete Manual, or the Handbook, for a fuller treatment of test selection.

GENERAL RULES FOR AN EXAMINATION

(Booklets K, A and B)

The examiner must be thoroughly familiar with the general procedure and specific directions for each test. **Things to be told to the children in the examination should always be read to them — never given from memory.** Directions given from memory invariably become inaccurate in some detail or other. The examiner should, however, be so familiar with the instructions that it is only necessary to glance at them in giving them and so that it is possible always to give the major attention to the children. **Read considerably slower than ordinary conversation, but in as conversational a manner as possible.** Be sure to speak loudly enough for all, and give special attention to distinct enunciation. **Follow rigidly the time allowances in the tests.** Use a stop watch.

The presence of an assistant in the lower grades may be an advantage if she, likewise, will follow instructions. She should be stationed in the rear of the room to keep children supplied with sharpened pencils, to help them keep their places in their booklets, and to assist in preventing various other kinds of distractions that may occur. She should limit her activities strictly to these matters, and under no circumstances should she give explanations or directions to a child in addition to what the examiner tells to all, nor at a time when the examiner is giving instructions. She should move about quietly and no more than necessary. She should not speak aloud to any child, and **not at all to the examiner.** All assistants should be carefully instructed beforehand.

In giving the preliminary instructions in the primary grades, the examiner's tone and manner should convey the impression that this is to be a pleasurable experience. If instructions are followed properly, children begin the test with interested anticipation. If they show anxiety or tension, either the teacher or examiner has been at fault in her handling of the situation. While handing out books, comment favorably, e.g., **I see we have some very good listeners here,** when children leave books as directed, and, if necessary, quietly remind children who open their books that they did not listen.

The examiner should bear in mind that the conduct of these preliminaries may affect materially the child's response to the test. Following the instructions in filling out the cover should be regarded as a fore-exercise in listening and following directions exactly. These instructions should therefore be given as carefully as the test itself.

A major problem in the administration of tests to young children is that of insuring entirely independent work. Instead of attempting to insure independent work by means of instructions, it is far preferable to divide the class into two or more sections for testing purposes. If this is done, children can be seated in alternate seats in alternate rows and the situation automatically insures the desired results. This is preferable from every point of view, especially as it affects the reliability of the test result. This procedure has consistently been the practice of the authors in securing the norms for the lower ages.

To insure sustained interest and optimum effort, it is desirable to interrupt the examination after the sixth test. A brief rest should be given. This should be handled in such a way that the continuity of the test situation is maintained. The children may be asked to stand beside their seats and "follow the leader" (the examiner) in stretching and relaxing activities.

The names of children who cannot yet write should be written on the booklets before distributing them. For the sake of accuracy, it is suggested that the examiner fill in the remaining blanks for Kindergarten, Grades I and II from available records, after the examination has been completed.

The time to be allowed for each trial, or for the test as a whole, after the examples are finished is always given at the top of the page and also in parentheses in its logical place in the instructions. Symbols are used for expressing minutes and seconds: e.g., 3 minutes (3′); 15 seconds (15″).

PRELIMINARY REMARKS TO THE PUPILS

(Booklets K, A and B)

Do not let anyone else make any preliminary announcements about the tests. First see that all the desks are cleared and that each child has a sharpened pencil. Then say,

"I'm going to have you do some things with me in these little books. Some of these things are something like picture games or puzzles, but they show me how well you can listen and then do them just as I ask you to. On each page I will show you what to do and then see how well you can do it all by yourself. I can tell you each thing only once, so you will need to listen carefully so you will know what you are to do."

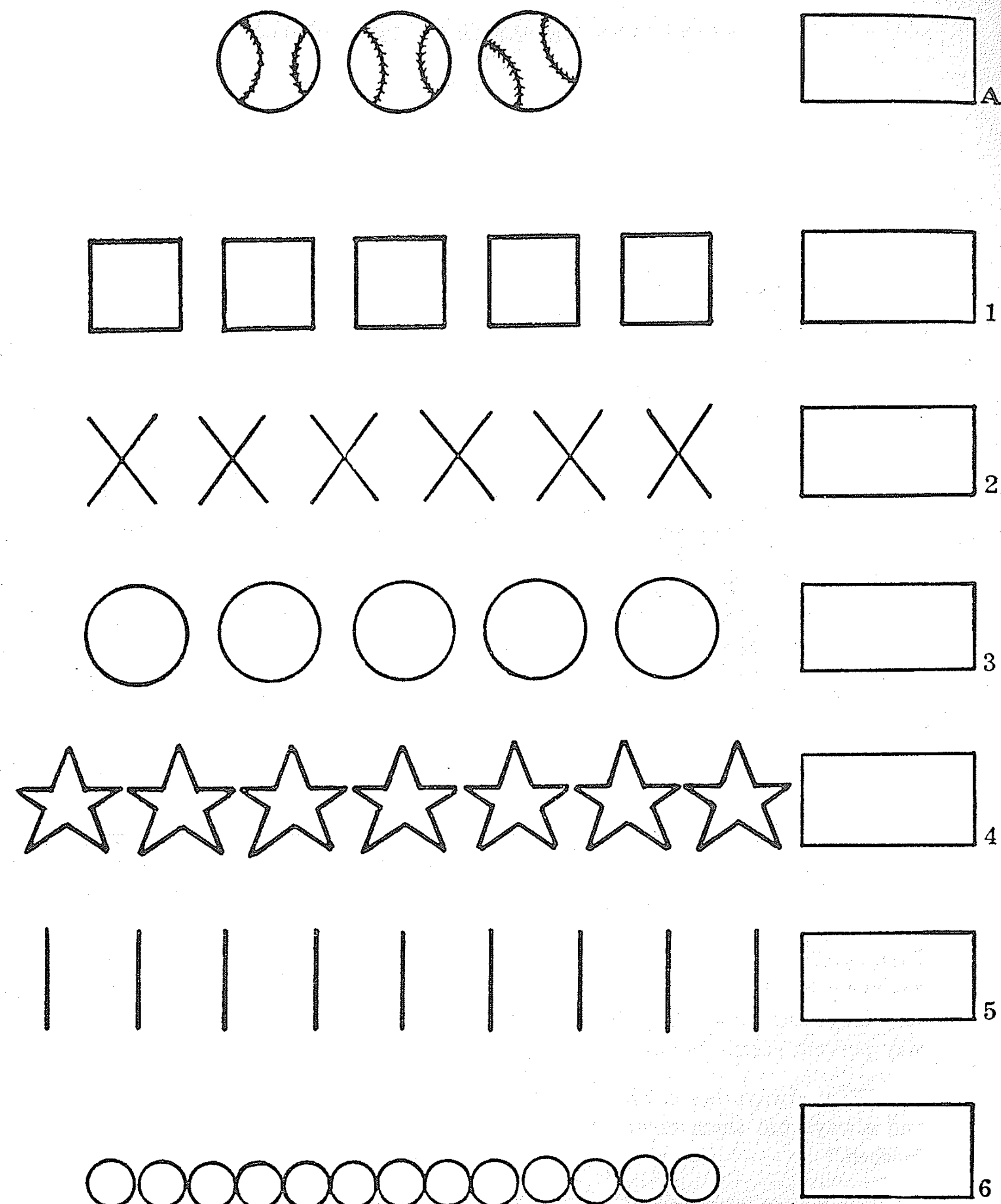
"I will give you each a book. Now this is the time to begin listening. Leave your book closed until I tell you what to do with it." Distribute the test booklets, face up, having teacher assist.

"Now I want to see how each one of you does these things all by yourself. Listen carefully and do it as you think it should be done. Take your pencils. Write or print your name as nicely as you can here on the top line after 'name.' (Allow time to do it. Then say,) **Now put your pencil down on your desk. Put your other hand over your book like this** (illustrate by placing a child's non-writing hand over the page) **and look up at me. Then I will know you are ready for the next thing. When I come around, let me see what you have done."**

"Most of the time I will tell you to make a dot somewhere. Just make a plain dot like this (make a plainly visible dot on the board) **that I can see easily when I look at your book. Now take your pencil. Make a dot up here at the top of your book.** (Show place on your book. Allow time to make it. Then say,) **Pencils down. Put your hand over your work."** (Go around and observe each child's dot. When the child has made an invisibly small dot or a very large dot, make a dot of appropriate size for him. Making too large dots may prevent completion of Tests 8 and 9.)

"Now always leave your pencils down until I tell you to take them up, and always put them down at once when I tell you to, even if you haven't finished."

"Now open your book." Begin with the first test at once.



Time: Allow 30 seconds for each of first five trials. Allow 40 seconds for **last trial.**

TEST 8

(First test for Booklet B)

EXAMPLE: **"You see the row of balls, and after the balls is a box. Put your finger on this box after the balls."** Point to box A in book. **"Now in this box you are to make as many dots as there are balls, one dot for each ball. Count the balls to yourself and then make as many dots as there are balls in this box after the balls. Take your pencils. Begin."** Go around and see that everyone has this right. Then say, **"Pencils down."**

Trial 1. **"Put your finger on the box after the squares. In this box make as many dots as there are squares, one dot for each square. Take your pencils. Begin."** (30″) **"Pencils down."**

Trials 2-6. Proceed exactly as in 1, changing only "squares" to

Trial 2. "crosses" (30″)

Trial 3. "circles" (30″)

Trial 4. "stars" (30″)

Trial 5. "sticks" (30″)

Trial 6. "beads" (40″)

At end of last trial say, **"Pencils down. Turn to next page."**

A

1

2

3

4

5

6

Time: Allow 15 seconds for each trial.

TEST 9

EXAMPLE: Hand and arm must be concealed from view of class while tapping.

"Leave your pencil down and just listen until I tell you to take it up. I am going to tap on the table and see if you can count the number of taps. Count the number to yourself. Listen." Tap five taps at the rate of one per second. **"Did you hear five taps?"**—Pause.—**"Then if I should say 'Make a dot for each time I tapped,' how many dots would you make?"**—Pause.—**"Five, that's right. Now take your pencils. On this top line with the 'A' by it, make five dots because I tapped five times. Begin."** (15″) **"Pencils down."** Go around and see that each child has this right.

"Now put your finger on the line with the 1 by it. I will tap again. Now sometimes I will stop tapping and begin again. Don't let that fool you. Count only those you hear. When I say 'Go,' take your pencil and for each time I tapped make a dot on the line with the 1 by it. Pencils down until I say 'Go.'"

Tap first series: "X" indicates a tap; "—" indicates a pause. Allow one second to each tap and each pause.

Trial 1. **"Listen!"** Tap series XX—XX. **"Go."** (15″) **"Pencils down."**

Trial 2. **"Now put your finger on the line with the 2 by it. Make your dots there this time. Pencils down. Listen!"** Tap series X—XX—XXX. **"Go."** (15″) **"Pencils down."**

Trial 3. **"And now the line with the 3 by it. Pencils down. Listen!"** Tap series X—XX—X—X. **"Go."** (15″) **"Pencils down."**

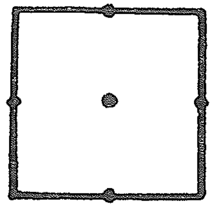
Trial 4. **"And now the line with the 4 by it. Pencils down. Listen!"** Tap series XX—XXX—X. **"Go."** (15″) **"Pencils down."**

Trial 5. Proceed exactly as above. Tap series X—X—XX—XXX.

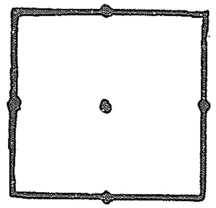
Trial 6. Proceed exactly as above. Tap series X—XXXX—X—XX.

At end of last trial say, **"Pencils down. Turn to next page."**

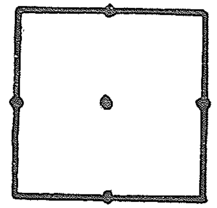
Note: Example for Test 10 should be drawn on the board before turning to the next page.



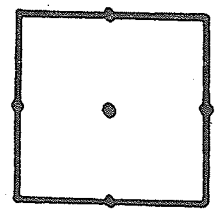
A



1



2



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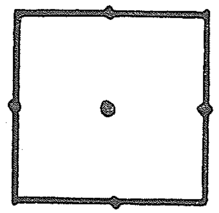

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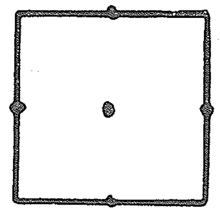


5

Time: Allow 15 seconds for drawing in square A. Expose each of the other squares 10 seconds. Remove card but allow 5 seconds more before showing next square so children may complete remembered lines.

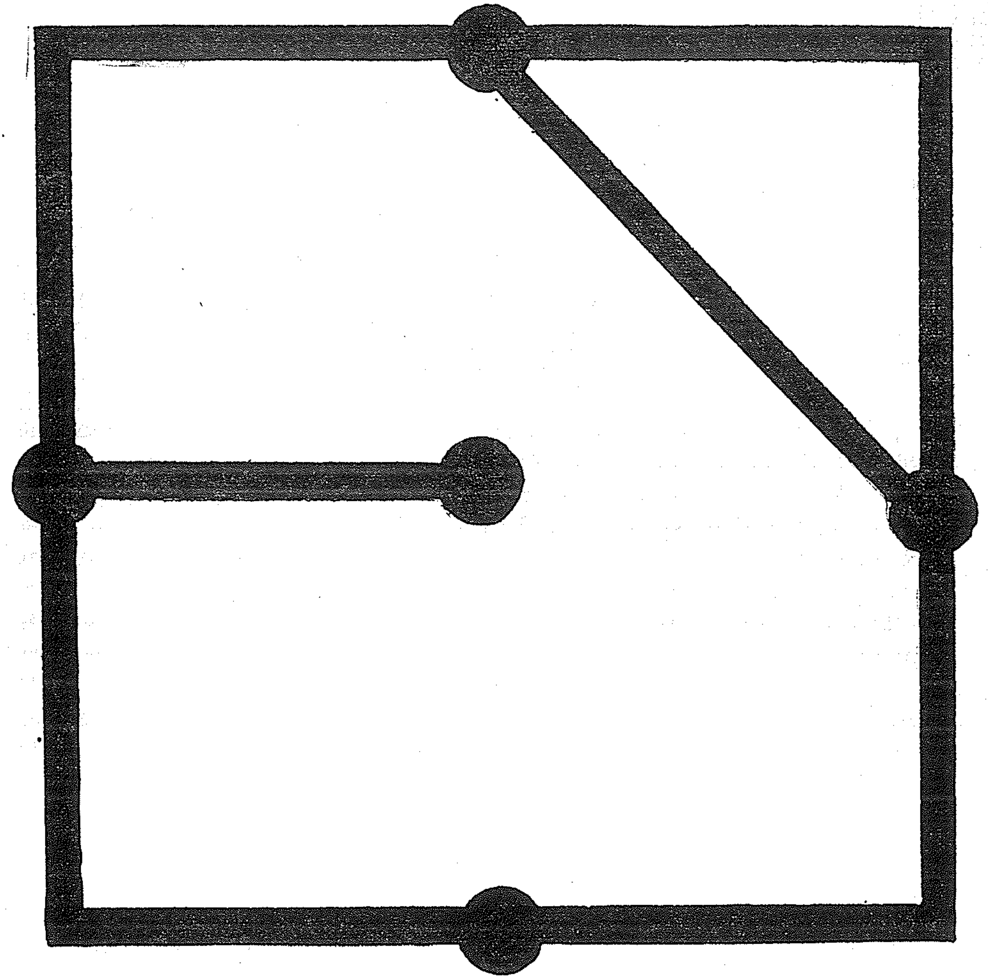
TEST 10

(Last test for Booklet K)

EXAMPLE: Have a square about five inches high drawn on the board before turning to this test, otherwise some children get the idea of drawing a square each time. Put "A" under the square, as in the book.

The squares to be used and the instructions for giving the example and the five trials are on the following pages. Before starting to give the test, open a test booklet at Test 10. For each trial, fold back the left page of the instruction manual so that the square to be shown is toward the class. Then cover the square with the test booklet, holding Test 10 in view of the class until the signal to draw is given. While reading the directions, point in the test booklet to the correct square as indicated and at the "Ready" signal, expose the large square by removing the test booklet. At the end of the exposure time, turn to the next page in the manual. Cover again with the test booklet in readiness for the next trial. The five second interval allowed for completing lines in each of Trials 1 to 5 allows sufficient time for examiner to be ready for the next trial at the "Pencils Down" signal.

This Side Up



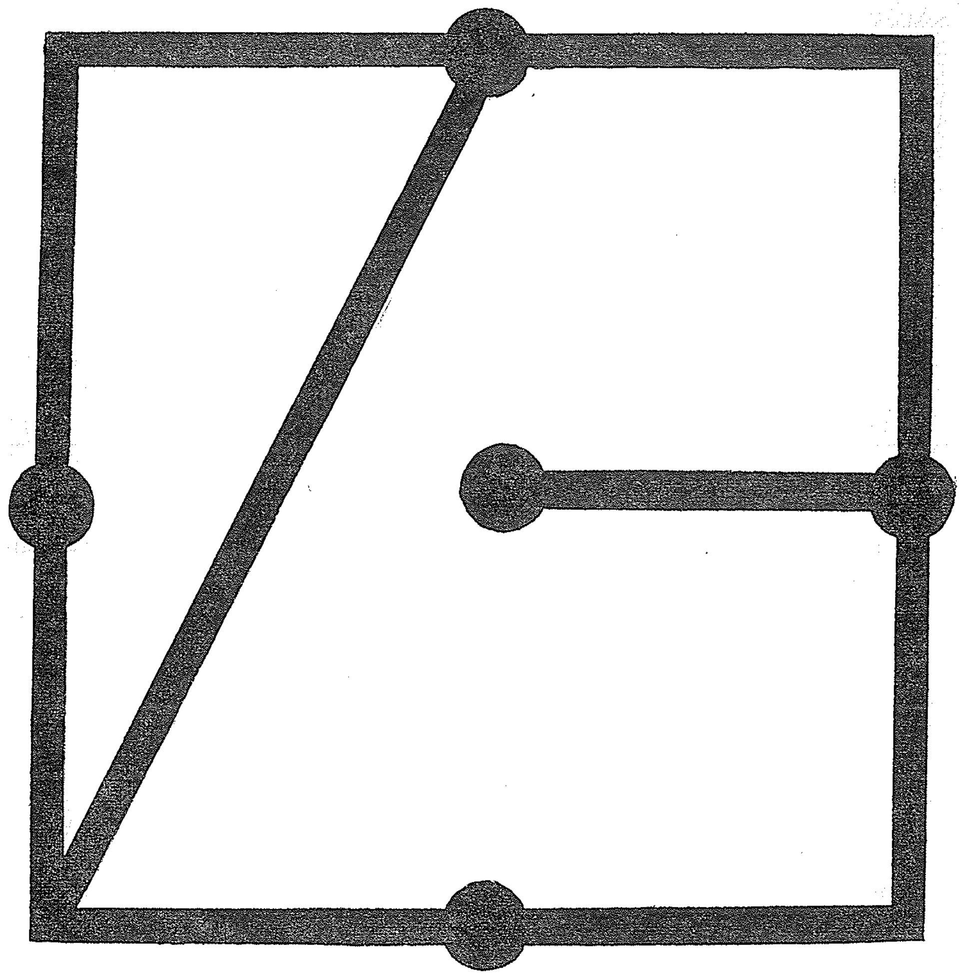
A

Time: Allow 15 seconds for drawing in square **A**.

TEST 10 — Trial A

"On this page you have some squares. Put your finger under this first square with the A under it. In this square, draw the two lines as they are in this one. Watch me first and see how I do it." Then illustrate on the board, using the square which has been drawn and keeping large square A in view of the class, saying as you draw: **"This line goes from this dot to this dot and this line from this dot to this dot. Now take your pencils. Draw like this in your square with the A under it."** Allow 15 seconds. Then say, **"Pencils down."**

This Side Up



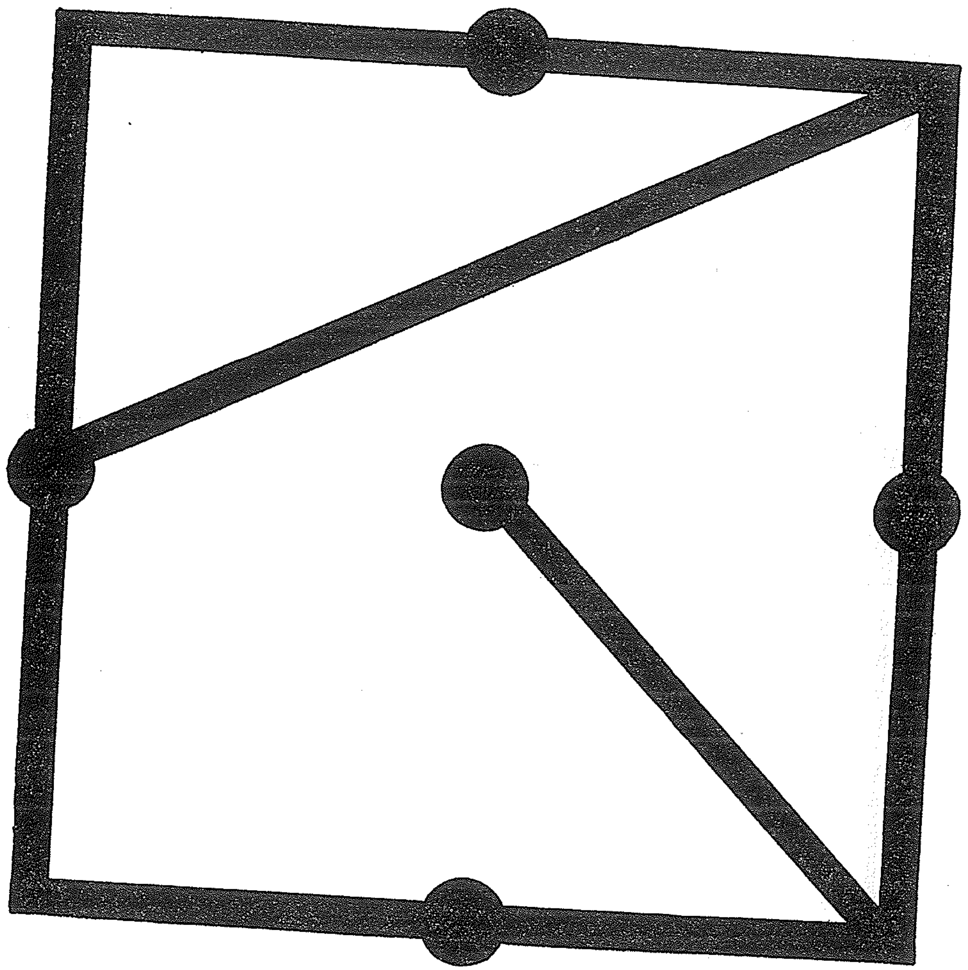
1

Time: Expose the square for 10 seconds. Remove card but allow 5 seconds more before showing next square so children may complete remembered lines.

TEST 10 — Trial 1

Trial 1. "Now put your finger under this next square with the 1 under it. In this square draw the lines I'm going to show you now. Begin drawing as soon as I show you the square. I am going to show it to you only a little while. Notice every line begins and ends at a corner or at a dot. Take your pencils. Ready. Draw." (Expose square 10″.) At the end of 5″ more say, "Pencils down."

This Side Up



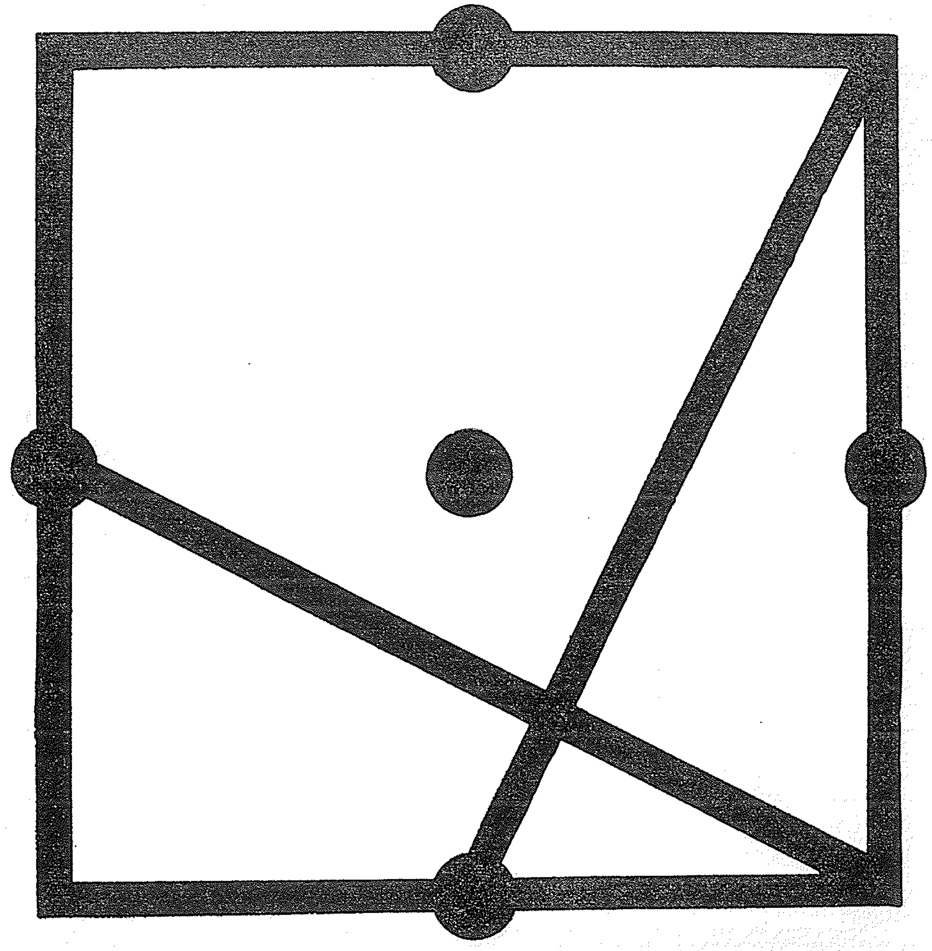
2

Time: Expose the square for 10 seconds. Remove card but allow 5 seconds more before showing next square so children may complete remembered lines.

TEST 10 — Trial 2

Trial 2. **"Now put your finger under the one with the 2 under it."** Show class as in Trial 1. **"In this square draw the lines I'm going to show you now. Take your pencils. Ready. Draw."** (Expose square 10″.) At end of 5″ more say, **"Pencils down."**

This Side Up



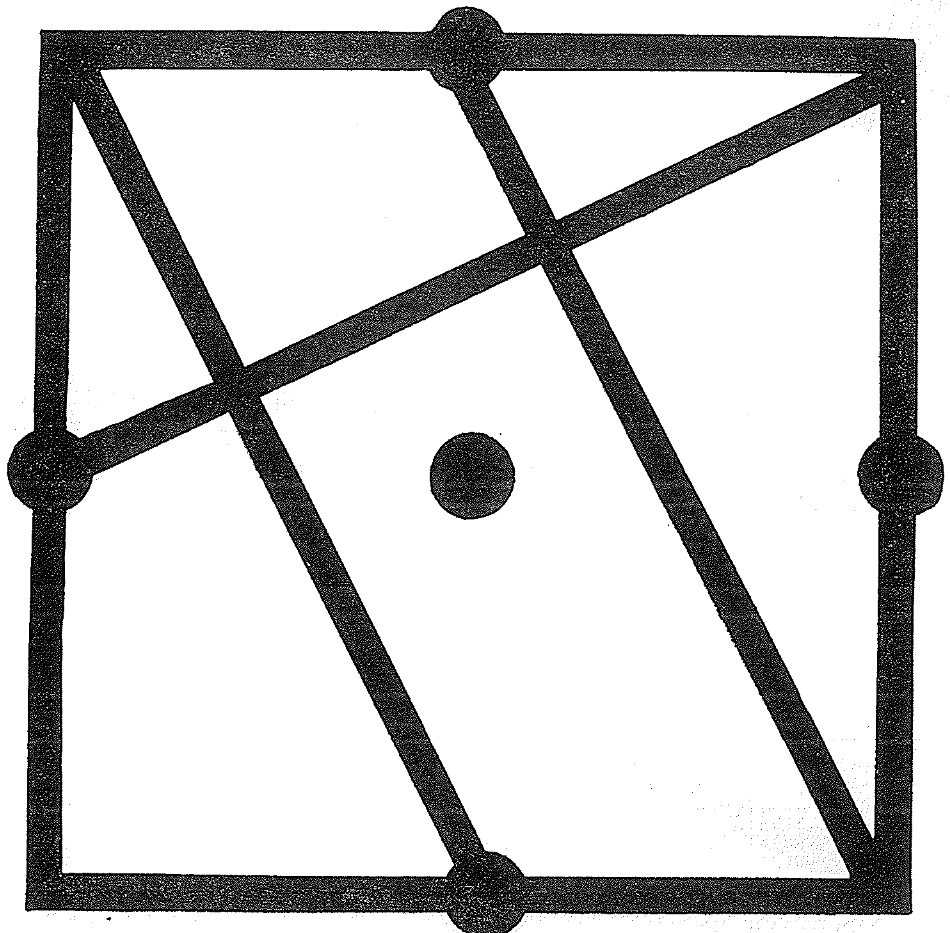
3

Time: Expose the square for 10 seconds. Remove card but allow 5 seconds more before showing next square so children may complete remembered lines.

TEST 10 — Trial 3

Trial 3. **"Now put your finger under the one with the 3 under it."** Show class as in Trial 1. **"In this square draw the lines I'm going to show you now. Take your pencils. Ready. Draw."** (Expose square 10″.) At end of 5″ more say, **"Pencils down."**

This Side Up



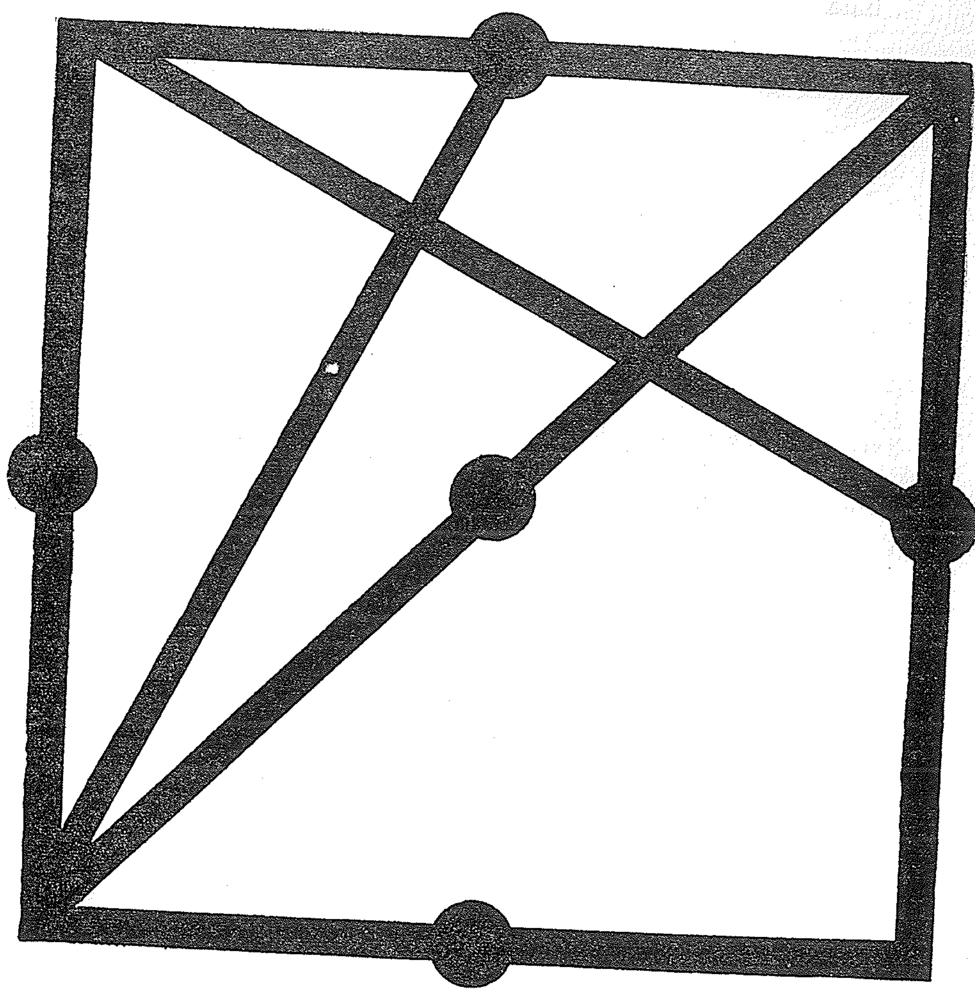
4

Time: Expose the square for 10 seconds. Remove card but allow 5 seconds more before showing next square so children may complete remembered lines.

TEST 10 — Trial 4

Trial 4. "Now put your finger under the one with the 4 under it. In this square draw the lines I'm going to show you now. Now this time I'm going to show you three lines. Take your pencils. Ready. Draw." (Expose square 10″.) At end of 5″ more say: "Pencils down."

This Side Up



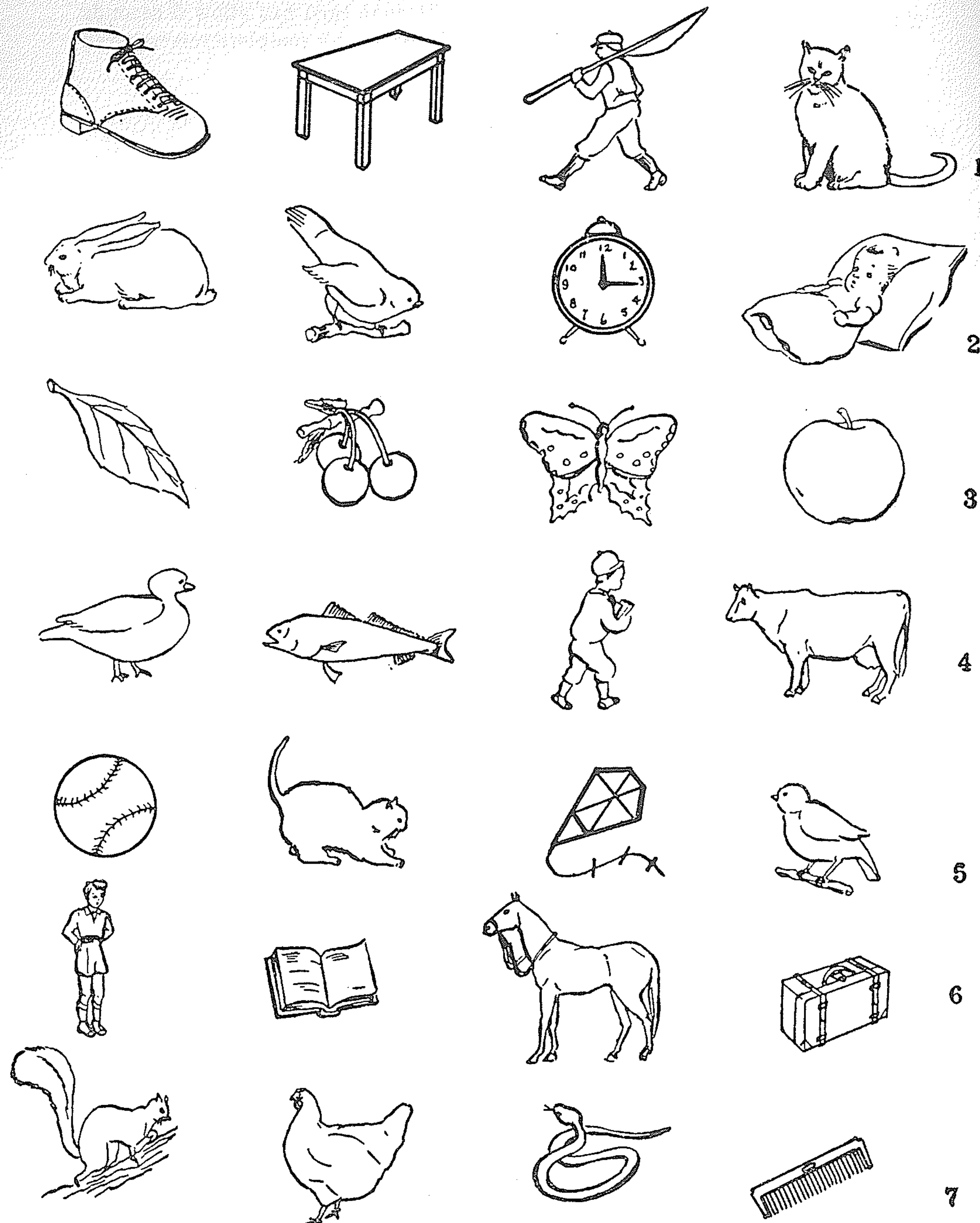
5

Time: Expose the square for 10 seconds. Remove card but allow 5 seconds more before showing next square so children may complete remembered lines.

TEST 10 — Trial 5

Trial 5. **"Now put your finger under the one with the 5 under it. In this square draw the lines I'm going to show you now. Now this time I'm going to show you three lines. Take your pencils. Ready. Draw."** (Expose square 10″.) At end of 5″ more say: **"Pencils down."**

At end of this trial say, **"Pencils down. Turn to next page."**



Test No. 11

Time: Allow 15 seconds for each trial.

TEST 11

Trial 1. "Look at the pictures in the top row on this page. There is a shoe, table, boy, and cat. Take your pencils. Make a dot on the one that has legs but canot walk." (15″) "Pencils down."

Trial 2. "Now look at the next row. You see a rabbit, bird, clock, and baby. Take your pencils. In this row make a dot on the one that has hands but canot sleep." (15″) "Pencils down."

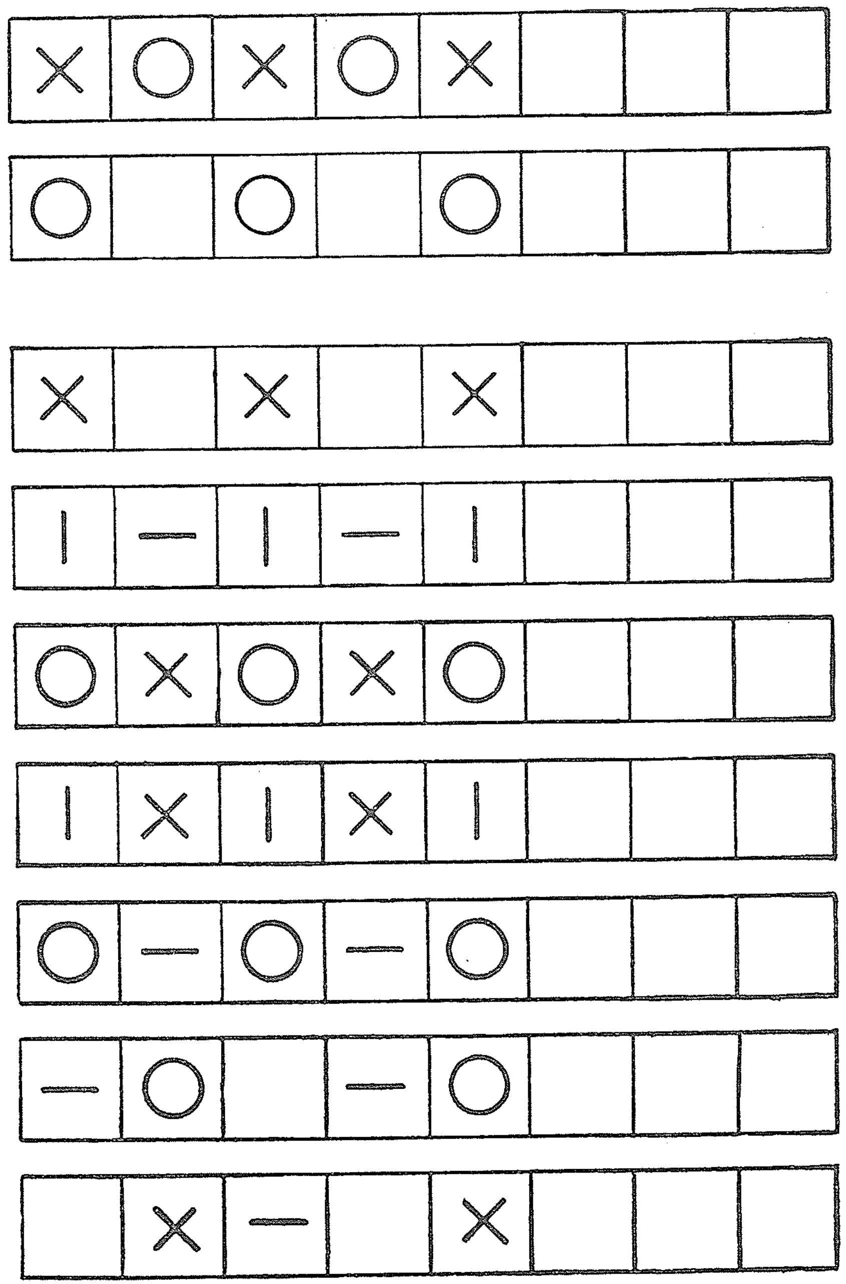
Trial 3. "Look at the next row beginning with the leaf. Take your pencils. Make a dot on the one that grows on a tree but cannot be eaten." (15″) "Pencils down."

Trial 4. "Look at the next row beginning with the duck. Take your pencils. Make a dot on the one that swims but cannot walk." (15″) "Pencils down."

Trial 5. "Look at the next row beginning with the ball. Take your pencils. Make a dot on the one that has no wings but can fly." (15″) "Pencils down."

Trial 6. "Look at the next row beginning with the boy. Take your pencils. Make a dot on the one that tells things but can't talk and can't walk." (15″) "Pencils down."

Trial 7. "Look at the next row beginning with the squirrel. Take your pencils. Make a dot on the one that has teeth but can't eat." (15″) "Pencils down. Turn to next page."



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Time: Allow 1 minute for the seven trials after examples are finished.

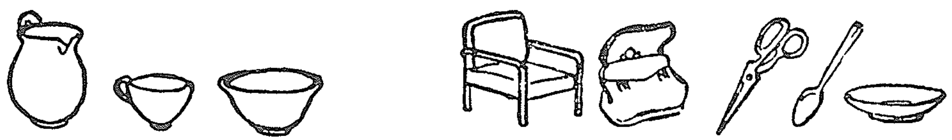
TEST 12

(First test for Booklet C)

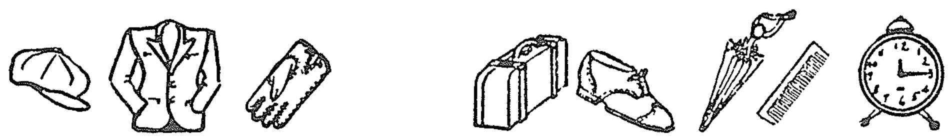
EXAMPLES: "Look at this top row of blocks. The first ones have something on them, but the last ones do not. We want to finish the last of the row just like the first of the row. We will see how the first of the row goes. On the first block is a cross, on the next is a circle, on the next is a cross, then a circle, then a cross, then what should come next?"—Pause.—"A circle, that's right. Take your pencils. Make a circle in that one. The next should have—(pause)—a cross. Make a cross. And the last—(pause)—a circle. Make a circle. Now the whole row goes the same all the way through; first a cross, then a circle, then a cross, and then a circle. Pencils down."

"Now look at the next row." Point to second row in book. "We want to finish the last of this row the way it is begun. The first block has a circle, the next has nothing, the next a circle, the next nothing, and the next a circle. Now what should be on the next block?"—Pause.—"It should have nothing on it, but the next should have—(pause)— a circle. Take your pencils. Draw a circle. And the next—(pause)—nothing. Now all of this row is the same, first a circle, then nothing, then a circle, then nothing, all the way through. Pencils down."

"Now do the other seven rows. See how the first of each row is. Then finish the last of each row like the first of the row. Take your pencils. Go." (1′) "Pencils down. Turn to next page."



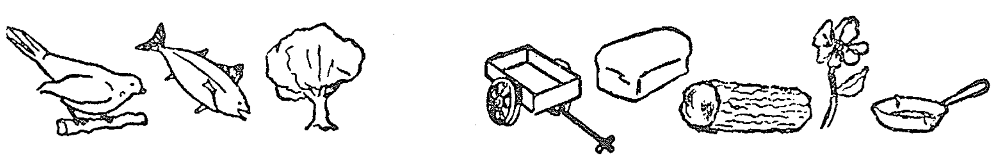
1



2

3

4



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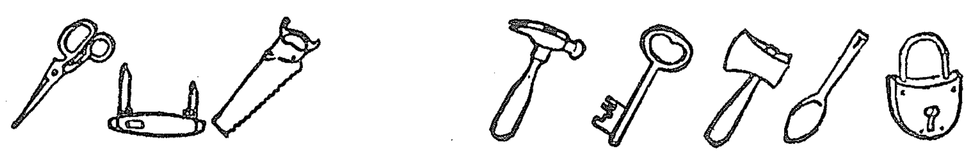


6

Time: Allow 15 seconds for each trial.

TEST 13

(Last test for Booklet A)

EXAMPLE: "Look at the pictures in this first row. You see there are three together and then some others after these. Now these first three are alike in some way. Can anyone tell in what way they are alike?"—Pause.—"Yes, they are all fruits." If another response is given, question until the right one is given or give it in case no one thinks of the right one. "Now among these other pictures here in the last of this row is one other that belongs with these first three. Do you see which one it is?" —Pause.—"Yes, the cherries, they are fruit too. Take your pencils. Make a dot under the cherries to show that they belong with the first three in the row. Go." (15″) "Pencils down."

Trial 1. "Now look at the next row beginning with the pitcher. Now don't tell me this time. Think of a way in which the first three in this row are alike, then find the one in the last of the row that belongs with the first three. Take your pencils. Put a dot under it when you find it. Go." (15″) "Pencils down."

Trial 2. "Now look at the next row beginning with the cap. Take your pencils. Put a dot under the one in the last of this row that belongs with the first three. Go." (15″) "Pencils down."

Trials 3-6. Proceed exactly as in 2, changing only "cap" to

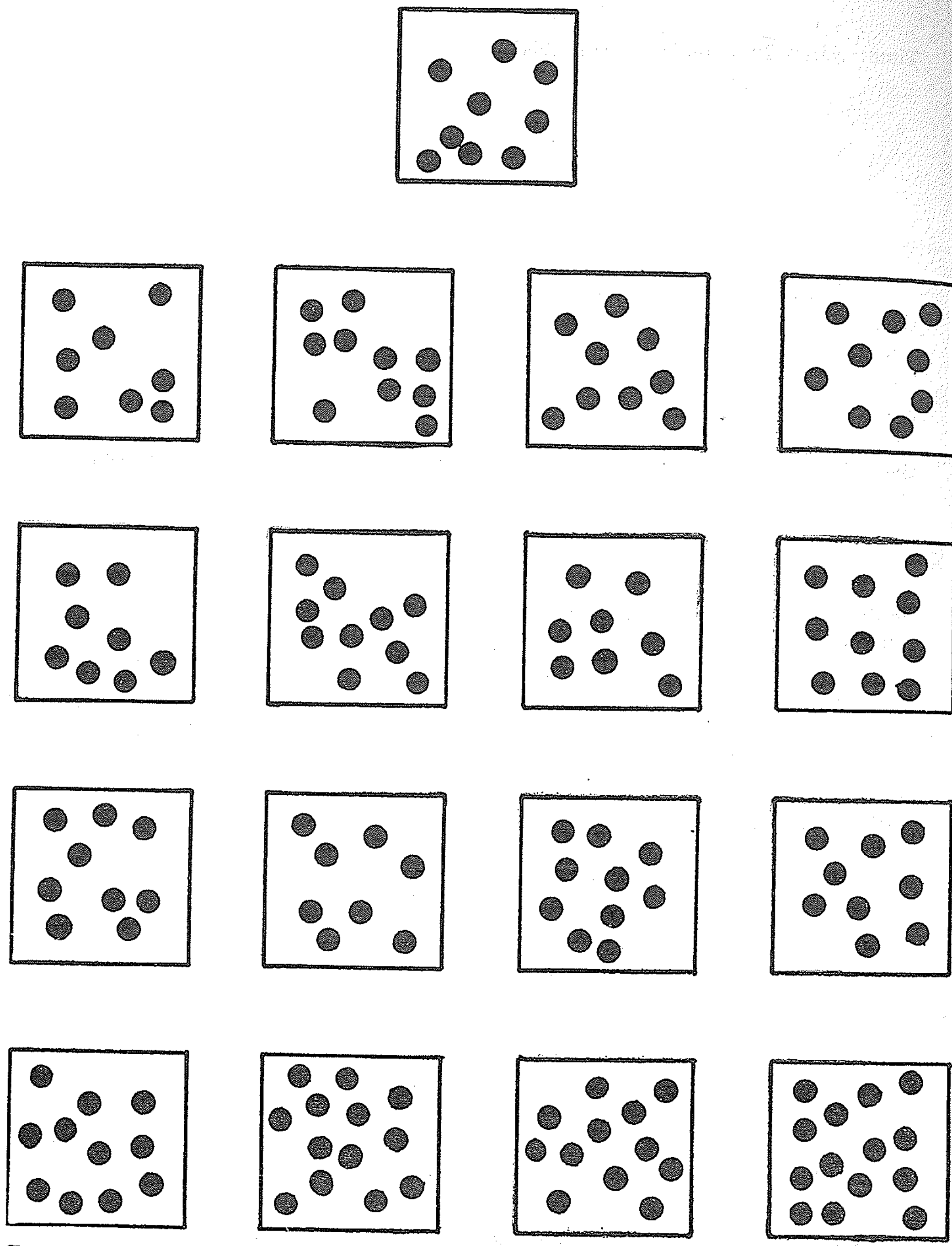
Trial 3. "chair" (15″)

Trial 4. "airplane" (15″)

Trial 5. "bird" (15″)

Trial 6. "scissors" (15″)

At end of last trial say, "Pencils down. Turn to next page."



Test No. 14

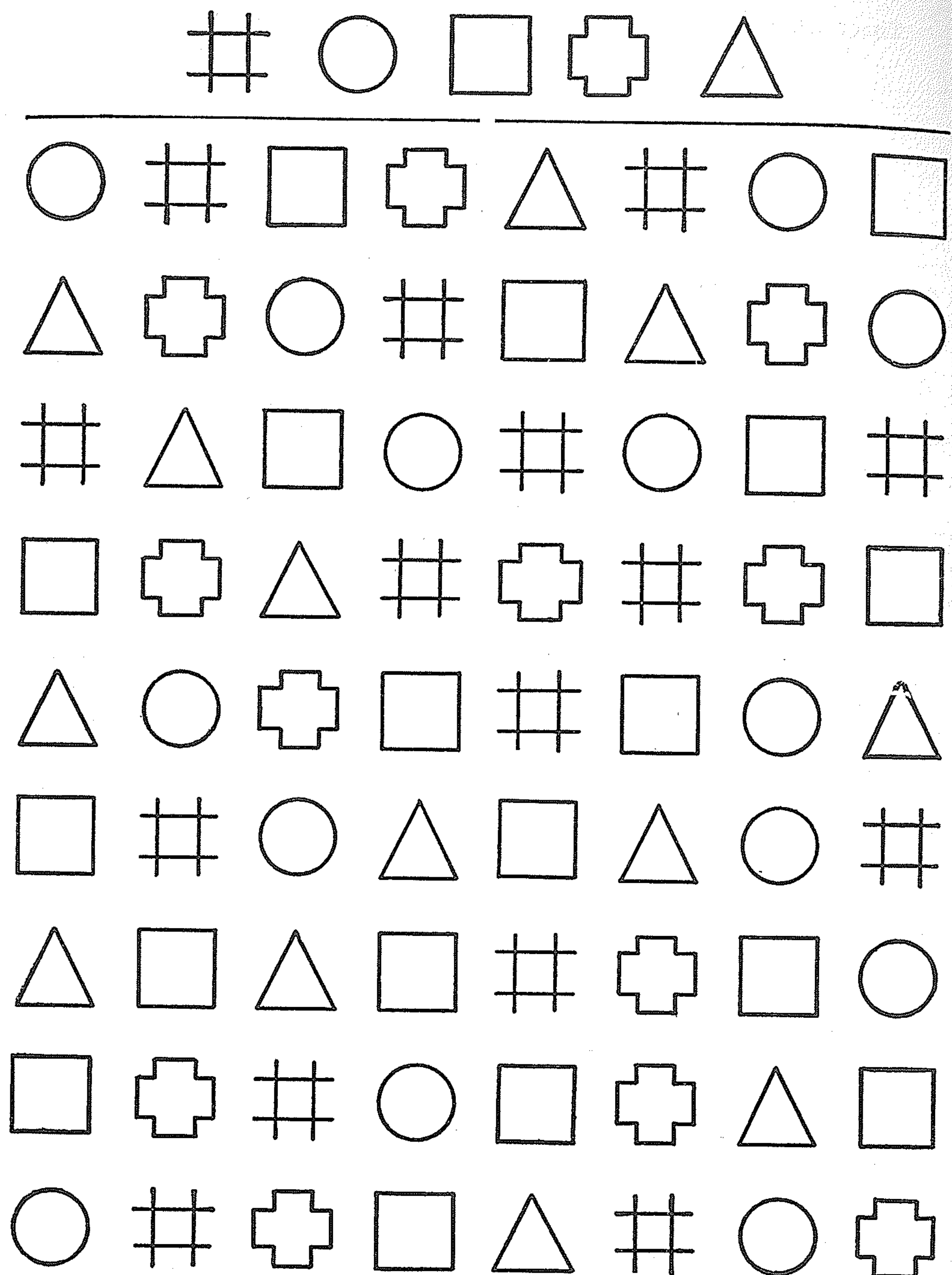
Time: Allow 1 minute for entire test after example is finished.

TEST 14

EXAMPLE: **"Now we are going to do something different. Listen carefully so you will understand what you are to do. Look at the square with the dots at the top of the page. Count the dots in it to yourself and see how many there are."**—Pause.—**"How many?"**—Pause.—**"Nine, that's right. Take your pencils. Write the number nine under this square to show that there are nine dots in it."** Write 9 on the board as this is said. **"Go."**—Pause.—**"Pencils down. Leave them down until I tell you to begin."**

"Now when I say 'Go,' begin with this first square. Count the number of dots in it to yourself. Then write the number under it which tells how many dots are in it. Then go on and do the next one and the next one and see how many squares you can finish until I tell you to stop, and when I say 'Stop' put your pencil down whether you are through or not. Keep your pencil in your hand while you are counting. Go." (1′) **"Pencils down. Turn to the next page."**

Note: Before turning to Test 15, have the first row of figures drawn on the board, 6 to 8 inches high. Beneath these, draw the same figures in the order, 3, 5, 1, 4, 2.



Test No. 15

Time: Allow 90 seconds for entire test after examples are finished.

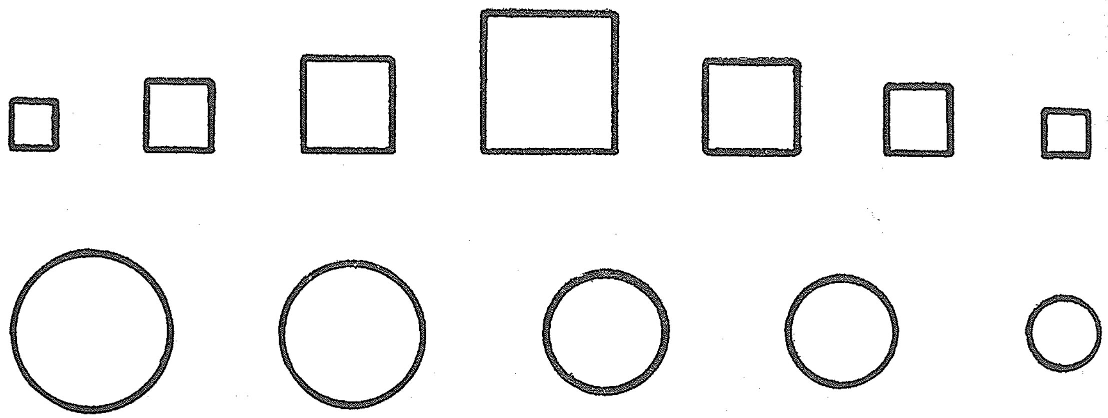
TEST 15

(First test for Booklet D)

"Look at the figures in the top row on this page. They are just like this, aren't they?" Point to the top row on board. **"Take your pencils. Write the number '1' on this one, the first figure in your book."** Point to it on board and write 1 on the figure, doing same with 2, 3, 4, 5, as you proceed. **"Write '2' on the next one, '3' on the next one, '4' on the next one, and '5' on the next one."**

"Now all pencils down." Leave figures on the board and point to the square in the second row on the board. **"Look at your book and see what number you have on this one."** Point to it on the board. **"What number?"**—Pause. **"Three, that's right."** Write it on the figure. Proceed in the same way for each of the others.

"Now leave your pencils down until I say 'Go.' When I say 'Go,' begin with this first figure and take one figure after the other and one row after the other, and see how many figures you can put the right number on until I tell you to stop. Take your pencils. Go." (90″) **"Pencils down. Turn to next page."**



Test No. 16

Time: Allow 20 seconds for each trial.

TEST 16

"On this page you see some squares and circles. I am going to tell you to do something with these squares and circles. Sometimes I will tell you to make a dot and then I mean just a plain pencil dot." Make one on board each time. **"Sometimes I will say, 'Make a cross' and then I mean one like this."** Draw an X on the board. **"Listen carefully and see if you can do it just right. Don't do anything until I say 'Go'."**

Trial 1. **"Keep your pencils up until I say 'Go.' When I say 'Go,' make a dot in the biggest square and a cross in the first circle. Wait, I will tell you again."** Repeat the directions. **"Go."** (20″) **"Pencils up."**

Trial 2. **"Listen again. When I say 'Go,' make a line under the first square and a dot under the smallest circle."** Repeat. **"Go."** (20″) **"Pencils up."**

Trial 3. **"Listen. Make a cross in the second square and a line above the last circle."** Repeat. **"Go."** (20″) **"Pencils up."**

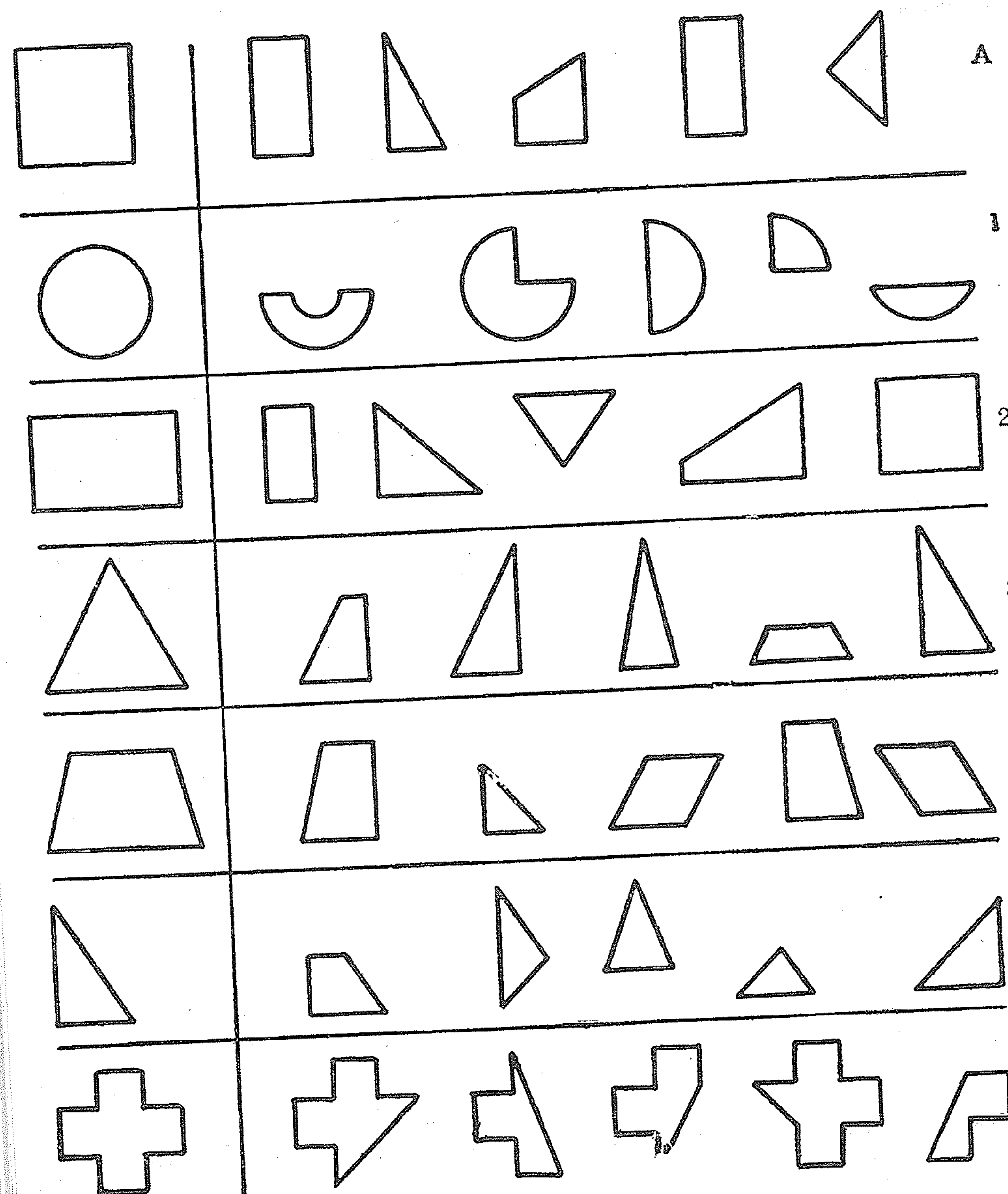
Trial 4. **"Now I'm going to tell you only once. Listen. When I say 'Go,' draw a line from the last square to the middle circle. Go."** (20″) **"Pencils up."**

Trial 5. **"Again. Draw a line from the biggest square to the smallest circle. Go."** (20″) **"Pencils up."**

Trial 6. **"Again. Make a dot above the biggest circle and a dot under the last square. Go."** (20″) **"Pencils up."**

Trial 7. **"Make a line in the fifth square and a dot in the fourth circle. Go."** (20″) **"Pencils up."**

Trial 8. **"Draw a line from the upper right corner of the first square to the middle of the next to largest circle. Go."** (20″) **"Pencils up. Turn to next page."**



Time: Allow 20 seconds for each trial.

TEST 17

(Last test for Booklet **B**)

EXAMPLE: **"Look at the top row of blocks. The first is a square. After it are five other blocks. Now among these five are two which would make a square like the first one, if we could put them together. Can you find those two? They look like this."** Draw the two about a foot apart on the board. **"If we could put these two together they would just make the square. Now make a dot in these two in your book to show they are the right two."** Illustrate by putting dots in two on board. **"Pencils up."**

Trial 1. **"Now look at the next row beginning with the circle. Find the two pieces in this row with the circle which could be put together to make a circle. Put a dot in the two that could make a circle. Go."** (20″) **"Pencils up."**

Trial 2. **"Now look at the first one in the next row. Find the two in the rest of the row which would make the first one. Put a dot in each one of them when you find them. Go."** (20″) **"Pencils up."**

Trial 3. **"Now look at the first one in the next row. Put a dot in the two in this row that would make the first one. Go."** (20″) **"Pencils up."**

Trials 4-6. Proceed exactly as in 3.

At end of last trial say, **"Pencils up. Turn to next page."**

TO SCORE THE TESTS

The General Procedure. Each of the ten pages in the test booklet is scored by counting the number of correct responses and obtaining a mental age (M.A.) equivalent for that number. After mental age equivalents have been obtained for all the ten test pages, the *median* mental age for the booklet is computed. This median mental age is then divided by the pupil's chronological age (C.A.) to obtained his intelligence quotient (I.Q.).

Accuracy in scoring tests and in computing results must be stressed at all times. To insure accuracy, all tests should be scored twice (preferably by two scorers), and the computations of C.A., M.A., and I.Q. should be double-checked.

The Materials for Scoring. Scoring the test pages requires use of the *scoring key folder,* the *test summary page* inside the front cover of the pupil's test booklet, and the test pages themselves.

To Score the Test Pages. Be sure that the key folder and the test booklet to be scored have the same letter designation. The scoring of each test page is accomplished in three steps:

1. Open the scoring key folder to the first key and place it beside the pupil's first test page. Compare the pupil's responses with those given on the key, and make a clear (preferably colored) mark on the test page by each *correct* response the pupil has made.

All correct responses should be marked by the scorer, even when this requires many consecutive marks. A response indicated by the pupil in a manner different from that requested by the examiner (such as a line or a cross instead of a dot) should be counted correct. So, also, a misplaced response (such as a mark under instead of on a particular figure) should be counted correct if it clearly designates the proper figure. A response is counted as wrong if a wrong part is marked in addition to the right part, unless there is evidence that the child has tried to correct his error by crossing it out or partially erasing it. Exceptions to these rules and other necessary details are given in the scoring key folders.

2. Count the number of correct responses on the test page and write this number in the upper right corner of the test page.

3. In the table of mental age equivalents opposite the key page in the scoring key folder, find the mental age equivalent for the number of correct responses noted on the test page. Write this mental age (years and months) in the upper right corner of the pupil's test page under the number of items correct.

To Summarize the Test Page Results. The scores should be transferred to the inside front cover of the test booklet. This involves two steps. The first step is essential to determine the median mental age. The second step is essential to the use of the profile graph. Both steps are recommended for the fullest use of the test results. In case only the median mental age is desired step two may be omitted. For each test page in the test booklet:

1. Locate in the columns at the top of the summary page the mental age that is written in the upper right-hand corner of the test page. Draw a line after this mental age. (If the same mental age equivalent is obtained on two or more test pages, draw an additional line or lines at slightly different angles.) Each zero score should be indicated by a line in the space provided below the lowest mental age in the mental age columns.

2. Record the number of *trials* correct on each test in the box under the profile graph which has the same number as the test page.

To Find the Median Mental Age. The mental age used in computing the pupil's I.Q. is the *median* mental age, based on all ten mental age equivalents obtained on the tests of a booklet. It is the mental age half-way between the *fifth* and *sixth* mental age equivalents obtained.

1. Begin at the top of the left hand column on the booklet cover and count through the successive mental age columns until the fifth lowest mental age, after which a line is drawn, is reached. Draw a small circle around it. Include any lines indicating zero scores in counting to the fifth lowest mental age. Now continue until the sixth penciled mark is reached. Draw a circle around the corresponding mental age. The median mental age is half-way between the two mental ages which have circles around them. To find this median: subtract the lower of the two mental ages from the higher; add half of this difference to the lower mental age. E.g. fifth and sixth M.A.'s are 10-4 and 10-10. Half of the difference ($6 \div 2 = 3$) added to 10-4 = 10-7. When this median mental age results in a half month, credit the student with the next full month (e.g., 10-7½ = 10-8). *This median should always be computed.*

If the same mental age equivalent has been obtained on two or three test pages (as indicated by the lines beside it), that mental age equivalent should be counted twice (or three times) in counting to the fifth and sixth mental ages. In this case the fifth and sixth may be at the same mental age equivalent. *That* mental age equivalent is then the Median Mental Age. Instances of this kind are relatively infrequent.

2. When the Median Mental Age has been computed, write it on the line designated "Median M.A." at the foot of the summary page.

To Compute the I.Q. The intelligence quotient is obtained by dividing the pupil's Median Mental Age (in months) by his chronological age (in months). Sixteen days or more are counted as a whole month.

1. The pupil's chronological age *at the time he took the test* is determined by subtracting the birth date from the test date on the front cover of the test

booklet. Always compute the pupil's *exact* age in years and months. This is most important because a small error will affect the pupil's intelligence quotient.

Example:

	Year	Month	Day
Date of testing	1952	4	17
Date of birth	1940	2	1
	12	2	16

Chronological age (C.A.) = 12-3

2. Write the C.A. and the M.A. on the first two lines designated "Test Results" on the front cover of the test booklet.

3. Compute total months for both M.A. and C.A. (i.e., 10 years and four months = 124 months).[1]

4. Divide Mental Age by Chronological Age (both expressed in total months) to obtain the pupil's I.Q.[1] *For all persons of chronological age 15 years and 6 months or over, divide M.A. by 15-6 (186 months).*

5. Write the I.Q. on the third line designated "Test Results" on the front cover of the test booklet and initial the line marked "Scored by."

To Complete the Profile Graph. In the profile of trials passed, make a heavy dot showing the number of correct responses on each test page. (This is the number that will have been written in the box under the graph.) Connect the ten dots with a continuous line to complete the profile.

The profile graph serves several useful purposes. It shows by inspection whether the booklet used is appropriate for the group and for the individual pupil. If the booklet used is appropriate for the group as a whole, the majority of the group will have a minimum of zero or maximum scores. Those pupils who are appreciably below or above the average ability level of the group will receive some zero and maximum scores, respectively. In case of more than two zero or maximum scores, the indication is that the use of the next lower or the next higher booklet, respectively, would contribute a more accurate mental age. (See the Master Manual or the Handbook, Part III, for discussion of profile and suggested follow-up testing for more refined measurement.)

Record of the Test Results. A complete and convenient test record for each pupil may be obtained by filing the front cover of his test booklet which contained all the necessary identifying data on the one side and the test-by-test record of results on the other side. A Class Record Sheet is also supplied.

[1] Or, employ: I.Q. Tables; I.Q. Calculator; or, slide rule.

APPENDIX X
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Control Group #7		Scores									
			Power Test (March)				Power Test (June)				
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T	I.Q.
Pupil											
#325	30/10/53	16	29	22	1	52	29	31	2	62	120
#326	27/3/53	13	26	20	1	47	35	34	2	71	113
#327	17/2/53	16	33	29	3	65	37	41	5	83	116
#328	22/10/53	16	31	32	1	64	36	42	4	82	127
#329	2/2/53	15	25	22	4	51	25	26	4	55	104
#330	28/2/53	16	30	29	2	61	34	39	4	77	121
#331	14/9/53	13	16	17	0	33	24	26	10	60	114
#332	19/3/53	15	27	32	1	60	37	40	3	80	114
#333	28/5/53	16	31	37	3	71	34	39	6	79	113
#334	13/4/53	16	33	27	0	60	35	40	3	78	110
#335	1/5/53	15	25	31	1	57	32	43	2	77	115
#336	1/7/53	13	23	25	1	49	22	28	1	51	117
#337	16/10/53	16	33	28	3	64	39	40	3	82	129
#338	23/9/53	15	30	25	3	58	35	32	2	69	119
#339	27/4/53	15	28	31	4	63	33	37	3	73	132
#340	30/8/53	16	36	26	1	63	32	37	2	71	121
#341	21/12/53	15	26	19	1	46	31	31	3	65	110
#342	23/4/53	16	27	18	2	47	32	31	4	67	122
#343	24/2/53	15	17	14	2	33	23	26	3	52	112
Control Group #8											
#344	25/5/53	13	34	28	1	63	34	29	4	67	117
#345	14/1/53	16	30	26	0	56	33	28	6	67	119
#346	29/9/53	16	34	24	1	59	34	34	1	69	116
#347	2/6/53	15	31	28	2	61	31	36	4	71	111
#348	17/2/53	16	27	25	0	52	24	31	5	65	116
#349	22/8/53	15	29	27	0	56	32	31	2	65	116
#350	24/11/53	16	28	23	0	51	33	32	3	68	110
#351	23/7/53	12	18	13	0	31	24	25	0	49	103
#352	22/4/53	13	31	26	2	59	33	33	2	68	112
#353	22/6/53	14	26	22	3	51	30	28	3	61	106
#354	16/7/53	14	27	26	0	53	30	30	0	60	117
#355	1/1/53	16	37	36	1	74	37	38	7	82	108

APPENDIX X
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Control Group #8		Scores									
			Power Test (March)				Power Test (June)				
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil											
#356	19/5/53	15	30	26	0	56	34	36	2	72	110
#357	31/7/53	15	30	27	1	58	38	35	5	78	127
#358	19/9/53	15	29	28	0	57	34	36	4	74	123
#359	29/6/53	13	27	25	1	53	38	32	2	72	122
#360	22/3/53	16	27	26	0	53	33	34	7	74	114
Control Group #9											
#361	12/12/52	15	28	22	0	50	29	31	2	62	110
#362	25/12/52	15	25	21	2	48	29	23	2	54	108
#363	25/9/53	16	27	21	0	48	35	30	1	66	125
#364	23/4/53	14	21	14	0	35	30	24	4	58	109
#365	12/3/53	14	20	18	0	38	33	30	1	64	111
#366	6/10/53	14	26	22	0	48	33	31	0	64	113
#367	12/11/53	16	30	27	0	57	36	32	1	69	125
#368	19/7/53	14	18	14	0	32	28	21	1	50	111
#369	7/1/53	13	21	20	0	41	31	29	0	60	110
#370	28/4/53	15	32	23	0	55	38	31	0	69	113
#371	15/10/53	12	25	14	0	39	28	23	1	52	120
#372	6/1/53	13	32	25	0	57	32	25	2	59	102
#373	6/12/52	16	28	21	0	49	30	29	1	60	106
#374	18/1/53	11	18	14	0	32	15	14	0	29	102
#375	15/1/53	16	23	17	0	40	31	24	2	57	107
#376	19/6/53	15	19	14	0	33	28	17	1	46	112
#377	20/2/53	15	29	20	1	50	32	30	2	64	108
#378	17/7/53	15	25	22	0	47	26	26	2	54	116
#379	19/5/53	15	21	7	1	29	27	24	3	54	102
#380	21/12/53	15	23	23	1	47	32	27	1	60	123
#381	6/6/53	14	20	14	0	34	26	20	2	48	113
#382	14/10/53	13	30	21	0	51	33	30	0	63	119
#383	25/6/53	12	27	23	1	51	34	23	3	60	115
#384	2/12/52	16	27	22	1	50	34	27	1	62	109

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Control Group #10		Scores									
			Power Test (March)				Power Test (June)				
Name of Pupil	Date of Birth	ART	P.I	P. II	P. III	T.	P.I	P. II	P. III	T.	I.Q.
Pupil											
#385	14/8/53	14	27	24	0	51	29	26	3	58	129
#386	15/11/53	9	13	12	0	25	19	16	2	37	110
#387	19/2/53	16	31	29	0	60	36	34	2	72	113
#388	10/11/53	16	29	26	0	55	32	33	2	67	121
#389	29/8/53	15	28	28	1	57	32	30	3	65	117
#390	20/1/53	16	31	26	3	60	32	30	6	68	117
#391	25/4/52	14	25	22	0	47	33	28	3	64	100
#392	5/6/53	14	24	16	0	40	34	28	4	66	117
#393	18/8/53	13	20	12	0	32	12	28	0	40	106
#394	10/7/53	15	13	23	0	36	23	23	2	48	113
#395	29/5/53	14	27	24	2	53	34	32	5	71	113
#396	22/9/53	16	32	27	1	60	36	31	4	71	134
#397	1/8/53	16	21	16	0	37	27	22	1	50	118
#398	31/3/53	14	16	9	0	25	19	19	3	41	112
#399	12/6/53	10	12	16	0	28	27	22	1	50	114
#400	20/7/53	14	17	12	0	29	20	20	0	40	112
#401	20/4/53	16	36	28	5	69	35	35	4	74	121
#402	2/8/53	13	24	17	0	41	31	25	3	59	119
#403	30/12/52	16	21	13	0	34	27	25	5	57	104
#404	12/10/53	13	23	21	1	45	23	26	3	52	120
#405	28/9/53	11	16	13	0	29	23	21	2	46	114
#406	17/7/53	14	23	23	0	46	26	26	3	55	124
Control Group #11											
#407	25/3/53	14	38	32	1	71	35	32	1	68	112
#408	19/12/52	15	26	19	4	49	29	23	3	55	107
#409	24/9/52	14	27	25	0	52	35	32	6	73	110
#410	4/7/53	9	16	15	4	35	18	13	1	32	102
#411	1/4/53	15	23	24	0	47	39	29	2	70	115
#412	17/2/53	16	25	24	0	49	35	27	4	66	106
#413	4/5/53	16	37	25	3	65	36	35	6	77	111
#414	16/1/53	15	25	21	0	46	36	31	3	70	108
#415	25/12/52	15	33	17	2	52	27	15	1	43	98
#416	11/3/53	15	32	29	2	63	37	33	7	77	117
#417	3/6/53	16	25	22	0	47	33	31	2	66	109
#418	30/12/52	14	36	32	1	69	35	36	7	78	109
#419	4/8/53	13	27	26	2	55	35	30	8	73	111