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The construction and analysis of a readiness test for the addition of fractions.

Carter, Mary Katherine
Boston University

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Boston University
BOSTON UNIVERSITY
SCHOOL OF EDUCATION

Thesis
THE CONSTRUCTION AND ANALYSIS OF A READINESS TEST FOR THE ADDITION OF FRACTIONS

Submitted by
Mary K. Carter
(B. S. in Ed., Salem State Teachers College, 1936)

In partial fulfillment of requirements for the degree of Master of Education

1953
First Reader: J. Fred Weaver, Assistant Professor of Education
Second Reader: Helen A. Murphy, Professor of Education
Acknowledgment

The writer is deeply grateful to Dr. Robert Burch and Dr. J. Fred Weaver for their assistance and guidance in the preparation of this study.
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CHAPTER I

PURPOSE AND SCOPE OF STUDY

THE PROBLEM

It was the purpose of this study to develop a test to determine readiness for beginning the study of the addition of fractions. Included in the study is an examination of the significant research which has been made in this particular field and an analysis of the underlying concepts and understandings upon which readiness depends.

JUSTIFICATION

Woody said, "When a pupil is ready for learning, he learns with ease and satisfaction. The meaningful development of the fraction concept depends on previous mathematical understandings. Because there are few tests adequate to measure readiness for fractions and since there is a definite need to ascertain readiness, the writer has constructed and analyzed a test to measure these underlying concepts and understandings.

SCOPE OF STUDY

A test was developed according to the plan in Chapter III. It was then administered to one hundred eighty fifth-grade boys and girls in six classes in three different schools located in a moderate socio-economic community. The test was given by the teacher of each class when she thought the children were ready to begin the formal study of the addition of fractions. The results were analyzed and interpreted in terms of the levels of intelligence, the levels of arithmetic achievement, and the chronological ages of the group. An item analysis was made of the individual items of the test.
CHAPTER II

REVIEW OF RESEARCH

Concepts of Readiness. In order to develop a test to determine readiness for beginning the study of the addition of fractions, it was essential that the meaning of the term "readiness" be clearly defined.

In 1937 Woody wrote:

The term 'readiness' is one of the latest additions to the family of educational concepts. The term usually refers to readiness for the mastery of things to be learned in the primary grades, although at the present time the concept is beginning to be used in connection with the learning of almost any topic to be taught in the various grades. Many articles have been published on reading readiness and several tests labelled 'reading readiness tests' have been developed within the last decade. More recently attention is being centered on arithmetical readiness. 1/

Woody found that the concept "readiness" as it appeared in the educational literature implied a number of meanings: biological readiness, psychological readiness, sociological readiness, and educational readiness. Biological readiness referred to the health and physical development of the learner. Psychological readiness had to do with


development of the nervous system and the functioning of the mental capacities. Sociological readiness referred to the needs of the child in his social surroundings. Educational readiness was concerned with the preparation which the teacher consciously made in getting the child ready to learn the things to be taught.

Woody went on to say:

Educational readiness presupposes centering attention on the learner: it consists of those things a good teacher does to connect the child's experiences with the things to be taught in order that understanding and mastery may result. When a pupil is ready for learning, he learns with ease and satisfaction. 3/

He did not confine his interpretation of the term "readiness" to the time at which formal instruction should be introduced, but had formulated principles which he felt constituted readiness for introducing any given operation in arithmetic. He summed up his views as follows:

Stress has been placed upon readiness as that state which evolves from an abundance of incidental and controlled educational experience, but knowledge of the language element of the situations involved, the ability to read any statements in which the element is presented, the mastery of all parts subsidiary to the new element, and the possession of a mental maturity commensurate to the mastery of the elements involved are essential. 4/

While the importance of all four aspects of readiness was emphasized by Woody, he stated that the teacher could do little about the biological and psychological readiness for learning. The teacher also could not control the sociological environment of the child. However, she could determine something of the nature of the child's experience and his incidental learnings and use these as a basis for future instruction. The teacher did have control over the child's educational readiness for learning a given subject. Even though many teachers may have contributed to the educational readiness of a pupil at a given moment, at the time anything was to be taught a given teacher was responsible for preparing the child for learning the thing to be learned.

Brownell was concerned with the concept of arithmetical readiness not as it was defined by the theorist, but as it was used by the teacher in setting his course of action. The theorist made much of the nature of readiness, its genetic development, and the factors constituting readiness. The teacher used an entirely different approach.


When the teacher had to decide when to introduce a new process or a new aspect of a process, he included some consideration of such items as the organization of arithmetic in the instructional materials used or in the local course of study, the amount of subject matter already taught and still to be taught in the school year, and whatever evidence was available of the pupil's ability to profit from instruction in the next step forward. Whatever the teacher used as basis for his decision amounted to an informal evaluation of readiness.

Dickey had this to say:

The combined effect of the changes in philosophy, psychology, and education, over the past ten years has been to direct attention to a search for the various levels of maturation, or stages of readiness, in the learner. Workers interested in the teaching of arithmetic are now becoming keenly interested in the grade placement of arithmetic, or arithmetic readiness. 7/

Sueltz stated:

Readiness in arithmetic is the stage in a child's development when it is opportune for him to proceed into a new experience or phase of learning. Readiness is really an integral part of modern education. It is not anything apart. It involves physical, emotional, social, and mental development. Experience, broadly conceived, is an important factor in readiness for arithmetic. 8/

7/ John W. Dickey, "Readiness for Arithmetic", Elementary School Journal, 40: 592, April, 1940.

How Readiness Is Achieved. Woody believed that readiness for the formal study of arithmetic presupposed that the child had had much incidental and concrete experience with the concepts, operations and processes involved. He went on to say:

The maxim 'from experience to expression' is applicable in the teaching of arithmetic as well as in the teaching of language and reading. This incidental and concrete experience may be of two types: that gained by the child in making his adjustment to his social and school life; and that which may be consciously built up by the teacher through games and exercises devised to teach concepts and number relationships, but always adjusted to the interest and level of the child's experience.

Woody maintained that the experiences with abstract number relationships, if properly related to concrete experience, after a while would take on the properties of the concrete and become part of the arithmetical experience through which new relationships, when correctly introduced, would take on meaning. Readiness for teaching any topic in arithmetic presupposed such concrete and first-hand experiences out of which the desired number relationship might evolve.

9/ Woody, op. cit., p. 316.
10/ Ibid, p. 316.
Before readiness could be established he presupposed that there was mastery of the language elements in the situation involved, since pupils who did not understand the language to be used in an arithmetic situation were not ready for instruction in solving that situation.

"Readiness for the teaching of any element in arithmetic," said Woody, "presupposes the ability to read such material as that containing the element to be taught." \[12\]
He went on to say that although he was not aware of any studies which established a high positive correlation between readiness for reading and readiness for arithmetic, he felt that such high relationship should exist. He also believed that readiness for the teaching of any element in arithmetic presupposed facility in handling all of the subsidiary parts making up the new element. The teaching of a new element should grow gradually out of the elements previously taught.

"It is the job of the school," said Sueltz, "to provide the stimulus in terms of experiences which will pro-

vide for each child the readiness he needs to proceed.

He continued:

The school must assume the responsibility for developing readiness. Readiness is not automatic; it is the result of experience, of thinking, of growth . . . Curiosity is an element of readiness. But we cannot, nor should we, teach and learn things merely because we are curious about them, and especially is this true if we are committed to meaningful learning and hold the aim of functional competence. 14/

15/

Sueltz believed that experience led to readiness and readiness led to further experience and learning. Because the experiences of children were so varied, their readiness to proceed with arithmetic was also varied. For this reason the school, he thought, had to assume the responsibility for providing meaningful experiences with numbers and measurements to build arithmetic readiness in the children, since all individuals respond to any new situation in accordance with past experience. He concluded, "Horizons must be broadened before real learning takes place." 16/

Testing in Relation to Readiness. In Brownell's investigation he tried to find out, "Just how ready are children in typical classrooms when the teacher determines

15/ Ibid, p. 516.
arithmetical readiness on purely practical grounds.\textsuperscript{17/} One implication of his study was that the practices most commonly used in the classroom were unsatisfactory for determining arithmetical readiness. Brownell went on to say, "Certainly it is not too much to suggest . . . that there is need for readiness testing, as well as for a program of remedial instruction to remove basic computational and other deficiencies."\textsuperscript{18/}

\[\text{Brueckner was of the opinion that the value of readiness tests as a basis of instruction in arithmetic and reading had been established. In the early stages of the development of readiness tests their primary purpose was considered to be prediction of future achievement. Later it became evident that a more valuable function of readiness tests was the diagnosis of factors likely to interfere with subsequent success.}

\[\text{Brueckner agreed that very little had been done to develop readiness tests for predictive purposes in the field}

\textsuperscript{17/} Brownell, Op. Cit., p. 15.

\textsuperscript{18/} Ibid, p. 22.

\textsuperscript{19/} Leo J. Brueckner, "The Development of Readiness Tests in Arithmetic," Journal of Educational Research, 34: 15, September, 1940.
of arithmetic for levels above the first grade. He felt that

the most useful function of readiness tests in the field of both reading and arithmetic was not prediction of success in the primary grades or any other grade, but the diagnosis of factors likely to interfere with learning at any level of the school at any stage of development, or in the study of any particular process or topic in the curriculum. To develop valid tests for predictive purposes it is the problem of the test maker to discover test content that correlates highly with some criterion of learning at a subsequent time. To develop valid tests for diagnostic purposes it is the problem of the test maker to discover the basic concepts, skills, and abilities the lack of which is likely to interfere with successful mastery of the next process or topic to be presented to the pupils. Then he must construct tests that will give satisfactory information about the present status of the individual with respect to these basic factors. On the basis of this information the teacher can then so organize the instructional program that steps can be taken to correct the conditions that otherwise might interfere seriously with the success of particular individuals in the study of the new topic or process about to be presented. 20/21/

Hildreth claimed that failure in the upper as well as the lower grades could be partly blamed on the essential lack of preparation in terms of mental knowledge or mental maturity. She believed that readiness data were important in indicating to the teacher what to expect under existing

20/ Ibid, p. 16.

curriculum conditions, and in understanding the learning progress rate for individual children. She maintained that her study indicated the need for more extensive arithmetic investigations of pupils in the initial stages of learning. Hildreth also said, "More extensive study should be made of arithmetic readiness through individual testing and more adequate measure of subsequent learning should follow."

Dickey was of the opinion that

The job of getting valid and reliable symptoms of arithmetic readiness is a task scarcely touched at present. . . have some insight into the approach which requires the best intuitive sense of an experienced teacher working in the classroom and possessing an extreme sensitiveness to the manifold and expressive kinds of behavior symptomatic of the learner's organized, and therefore meaningful quantitative thinking done at his level of maturation. The best observation which can be made by the classroom teacher while in the process of teaching is the evidence to be used to determine arithmetic readiness on the part of the learner, but very little of this observation has been used to help solve the problem of readiness for arithmetic. The experienced teacher, aware of the problem of arithmetic readiness and the concepts involved, is the key to the entire situation.

Brownell proposed that readiness be determined by one's experiences and he presented his position as follows:

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22/ Ibid, p. 5.

Arithmetical development is viewed as the product of arithmetic experience. A child is 'ready' to learn a new arithmetic topic when he has control of all ideas and skills prerequisite thereto. Incidentally - but only incidentally - he will also probably have attained a general maturity which will make learning easier. The main thing, however, is that his previous experience will have brought him to the stage where he can now take on the new learning.

Once we are sure that children have had the necessary foundational experience (and this fact can be ascertained through appropriate tests) we can teach that topic, whether it be at the mental age of ten years or at the mental age of nine or eleven, whether in Grade V or in Grade IV or VI. 24/25/

Washburne stated that the work of the Committee of Seven had brought out strongly the need for knowing the child's mental maturity and his readiness for learning a given topic. Schools gave too little attention to both factors. They tried to teach children before the children had reached the necessary mental maturity; they tried to build inadequate foundations. This resulted in waste, inefficiency and frequent failure.

He emphasized the fact that failure had been more common in arithmetic than in any other school subject above the first grade. He felt that the work of the Committee of


Seven had shown one of the principal causes of the failure and had brought out the means of prevention.

Washburne further concluded that

Unless adequate foundation tests are provided for the beginning of each new process, and unless the teacher is instructed as to the importance of knowing whether the child who is going to undertake the process is ready mentally and in terms of foundations, the mere postponing of a topic one or more grades will only partially solve the problem of teaching each arithmetic topic at the most desired level. 26/

Spitzer said that in the description of the testing practices of a single classroom, two important purposes of tests were identified: (a) determining the status of the pupil's mastery of arithmetic as measured by the survey or achievement type of test, and (b) determining where a pupil's knowledge or skill breaks down, as indicated by the diagnostic test. He continued, "A third, though much less common purpose of tests, that of determining readiness for new work is not so easily identified. Some inventory tests have determination of readiness as an objective." 27/


28/ Ibid, p. 188.
Sueltz commented that attention had been directed toward two general methods of evaluating understanding in elementary school mathematics. One was by use of paper and pencil exercises and the other was by observation, discussion, and interview. He believed that a combination of both methods was desirable for a comprehensive evaluation. He also maintained that a thorough knowledge of the nature of mathematical learning, particularly of understanding and meaning, enabled a teacher to determine when one technique of testing was better than another. He went on to say:

Teachers are counseled to observe and to discuss with their pupils the developmental and understanding phases of mathematics. Furthermore, the well-trained and experienced teacher should give marks or scores on these phases of mathematics just as he does on abstract computations. Usually it is found that pupils who have not developed meanings and understandings as they are learning mathematics do not learn to compute well and do not sense the essential mathematics in a social or economic situation.

The measurement of meanings and understandings is beginning to creep into research in arithmetic. Of 27 studies examined, eight showed that the author was

deliberately trying to measure beyond the traditional scope of computations and problem solving. New procedures in teaching and evaluation will need to be developed as the schools broaden their vision of the function and scope of mathematics. 30/

31/ Spitzer reported that readiness tests in upper-grade arithmetic have been even less popular than those for pupils in the primary grades. He did not know whether this lack of progress in readiness testing in arithmetic was due to teacher indifference, to the great emphasis given to reading readiness, to the nature of arithmetic, to the lack of satisfactory testing instruments, or to some other unknown reason.

"That there is little interest at present," stated Spitzer, "is probably the best statement that can be made on the status of arithmetic-readiness testing." 32/

In this connection Spitzer went on to say, "Commercially distributed readiness tests in arithmetic have not reached any high level of popularity, and, as a result, only a few are on the market." 33/

30/ Ibid, p. 156.


33/ Ibid, p. 192.
Mental Age as a Factor in Readiness

There is some disagreement as to the importance of mental age in respect to readiness. Osborne believed that:

In general there is a stage of mental growth for each topic in arithmetic before which it is wasteful of time and energy to attempt to teach it, and a stage beyond which there is little to be gained by further postponement. 34/

Washburne seemed to agree with this view.

To attempt to teach a topic before either the minimum or optimum stage of mental growth is reached is not merely to waste much time and effort on the part of teacher and pupil, but to doom a considerable number of children to failure, and a much larger number to the hazy half knowledge, so characteristic of children's grasp of arithmetic and so inimical to the clear thinking and sure-footed progress that should characterize the study of mathematics. 35/

Woody, however, was of the opinion that, although mental age was important, when adequate investigations were available:

... the same situation in the learning of arithmetic will prevail as was found by Gates in his extensive study of the factors predictive of reading readiness, viz., that whenever a dominant


purpose prompts the mastery of reading the child possesses the mental capacity to master the process. There is considerable evidence pointing to this conclusion concerning the mastery of the operations of arithmetic. 36/

He went on to say, "To determine accurately the mental level essential to the mastery of a given element in arithmetic is a very complicated process. Much attention must be given to the processes of instruction preliminary to the introduction of the given element." 37/

Brownell observed that

The Committee of Seven view readiness as the result of some inner maturation, not as the product of experience. The conception of readiness logically required by the committee recommendation for the separate processes is unsound psychologically and is likely to be misleading educationally. 38/

He went on to say, "Thus the effects of merely growing older tend to be exaggerated and the influences of experience and direct instruction tend to be minimized." 39/

37/ Ibid, p. 320.
Conclusion. Readiness is not a simple concept. It includes, as heretofore stated, different aspects: biological readiness, psychological readiness, sociological readiness, and educational readiness. The teacher, although recognizing the importance of all phases of readiness, is more concerned with educational readiness since that is the phase over which she has some control. For the purposes of this thesis, then, the writer is concerned with educational readiness or what the teacher can consciously do to get the child ready to learn to add fractions. As Swenson said, "If a child or group of children do not seem to possess adequate readiness, the teacher's next step is one of positive action rather than passive waiting."

CHAPTER III

THE PROCEDURE

The Problem. It was the purpose of this study to develop a test to determine readiness for beginning the study of the addition of fractions. Since the writer could find no list of the underlying concepts and understandings upon which this aspect of readiness depends, the following list has been evolved from her own critical analysis of the process of adding fractions:

1. Ability to write fraction using numbers when fraction is given in words.
2. Ability to write fraction in words when fraction is given in numbers.
3. Ability to recognize the fractional parts into which a figure is divided.
4. Ability to divide figures into fractional parts, understanding that the figure has to be divided into equal parts.
5. Ability to recognize out of a group of figures marked off into four parts which of the figures are divided into fourths (four equal parts).
6. Ability to find a fractional part of a group.
7. Ability to recognize a fractional part of a group.
8. Ability to recognize that the numerator tells the number of parts and that the denominator tells the size of the parts.
9. Ability to recognize that as the denominator gets larger the size of the parts gets smaller and vice versa.
10. Ability to recognize that comparisons can only be made of like things.
11. Ability to recognize that only like things can be added.

Construction of the Test. As soon as the underlying concepts and understandings upon which readiness for fractions depends were determined, it was necessary to construct the test items. After a careful study of what constitutes good test construction as set up by Rinsland, Greene, Jorgensen, and Gerberich, and Orleans, the writer began the

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building of the test items to include those abilities. The
following shows in which sections of the test the specific
abilities are measured:

<table>
<thead>
<tr>
<th>Parts of Test</th>
<th>Abilities</th>
<th>Parts of Test</th>
<th>Abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1,2</td>
<td>III</td>
<td>5,6,7,9</td>
</tr>
<tr>
<td>II</td>
<td>3,4</td>
<td>IV</td>
<td>8,11</td>
</tr>
</tbody>
</table>

**The Program of Testing.** When a teacher, who had
been previously contacted, thought her group was ready to
begin the formal study of the addition of fractions, she
notified the writer who delivered the test and the direc-
tions for administering it. Each teacher then administered
the test to her own class. The testing was done during the
month of December, 1951. Upon the completion of the test,
the teacher returned the test papers to the writer for scor-
ing and analysis.

**Other Data Available and Used.** The measure of the
level of achievement in arithmetic was readily available
from the results of the Metropolitan Achievement Tests, Form
R. which had been given in March of the preceding school
year. The intelligent quotient of each child was obtained
from the Kuhlmann-Anderson Intelligence Test results which
had been obtained in October, 1951. This is an indication
of the nature of the data that were collected, presented,
and analyzed in the following chapter.

The results were analyzed in terms of their relation to the factors of chronological age, intelligence quotients, and achievement. An item analysis of the individual items on the test was made.

There was no experimental try-out of the test. This represents the test as originally constructed. Suggestions for revision will be found in the summary.
CHAPTER IV

ANALYSIS OF DATA

The purpose of this study was to construct and analyze a test to determine readiness for beginning the study of the addition of fractions.

The test was administered to one hundred eighty pupils from six fifth-grade classes from three different schools in the same community. One hundred of the pupils were boys and eighty were girls. A series of frequency tables follows to aid in describing the group.

Table I shows the frequency of each chronological age interval within the group along with measures of central tendency and spread. The mean was found to be 10-4 which is about normal for fifth grade. The range was from 9-0 to 14-8 with a standard deviation of 9.4. Closer examination will show that a few overage children are responsible for the wide range of ages, but that the great majority of the group fall between 9-0 and 11-5.

Table II shows the frequency of each intelligence quotient interval within the group along with measures of central tendency and spread. The mean was 108.5 which indicates this group to be above average in intelligence. The range was from 68 to 137 with a standard deviation of
TABLE I

DISTRIBUTION OF THE CHRONOLOGICAL AGES OF 180 PUPILS

<table>
<thead>
<tr>
<th>AGE IN YEARS AND MONTHS</th>
<th>NUMBER</th>
</tr>
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<tbody>
<tr>
<td>14-6 to 14-11</td>
<td>1</td>
</tr>
<tr>
<td>14-0 to 14-5</td>
<td>0</td>
</tr>
<tr>
<td>13-6 to 13-11</td>
<td>1</td>
</tr>
<tr>
<td>13-0 to 13-5</td>
<td>2</td>
</tr>
<tr>
<td>12-6 to 12-11</td>
<td>0</td>
</tr>
<tr>
<td>12-0 to 12-5</td>
<td>2</td>
</tr>
<tr>
<td>11-6 to 11-11</td>
<td>4</td>
</tr>
<tr>
<td>11-0 to 11-5</td>
<td>15</td>
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<td>20</td>
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<tr>
<td>10-0 to 10-5</td>
<td>80</td>
</tr>
<tr>
<td>9-6 to 9-11</td>
<td>43</td>
</tr>
<tr>
<td>9-0 to 9-5</td>
<td>12</td>
</tr>
</tbody>
</table>

N = 180
M = 10-4
SD = 9.4
of 13.2. Although the spread of intelligence quotients is wide, study will show that a few children on either end are responsible for this, but that the great majority of the group fall between 93 and 127.

Table III shows the frequency distribution of the scores on the arithmetic sub-tests of the Metropolitan Achievement Tests, Form R, as translated into local grade equivalents along with measures of central tendency and spread. In order to interpret these results, it must be noted that these tests were administered in March of the preceding school year when these children were in grade four. The community used in this study has established local grade scores which tend to be lower than the national ones. The national grade score for grade four at the time this test was administered was 4.7. The mean was found to be 4.9 which, in the light of the stated facts, shows this group to be above average in arithmetic achievement. The range was from 4.4 to 5.5 with a standard deviation of 0.4.

Table IV shows the frequency of each score interval within the group on the Readiness Test for Beginning Study of the Addition of Fractions along with measures of central tendency and spread. The mean was found to be 33.5. The range was from 4 to 46 with a standard deviation of 8.8. Although the range of scores is wide, closer examination
### TABLE II

**DISTRIBUTION OF INTELLIGENCE QUOTIENTS DERIVED FROM THE KUHLMANN-ANDERSON INTELLIGENCE TEST**

<table>
<thead>
<tr>
<th>INTELLIGENCE QUOTIENTS</th>
<th>NUMBER</th>
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<tr>
<td>133-137</td>
<td>4</td>
</tr>
<tr>
<td>128-132</td>
<td>4</td>
</tr>
<tr>
<td>123-127</td>
<td>16</td>
</tr>
<tr>
<td>118-122</td>
<td>21</td>
</tr>
<tr>
<td>113-117</td>
<td>26</td>
</tr>
<tr>
<td>108-112</td>
<td>36</td>
</tr>
<tr>
<td>103-107</td>
<td>22</td>
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<tr>
<td>98-102</td>
<td>14</td>
</tr>
<tr>
<td>93-97</td>
<td>16</td>
</tr>
<tr>
<td>88-92</td>
<td>8</td>
</tr>
<tr>
<td>83-87</td>
<td>6</td>
</tr>
<tr>
<td>78-82</td>
<td>2</td>
</tr>
<tr>
<td>73-77</td>
<td>3</td>
</tr>
<tr>
<td>68-72</td>
<td>2</td>
</tr>
</tbody>
</table>

\(N = 180\)

\(M = 108.5\)

\(SD = 13.2\)
<table>
<thead>
<tr>
<th>GRADE SCORES</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4 - 5.5</td>
<td>4</td>
</tr>
<tr>
<td>5.2 - 5.3</td>
<td>16</td>
</tr>
<tr>
<td>5.0 - 5.1</td>
<td>48</td>
</tr>
<tr>
<td>4.8 - 4.9</td>
<td>31</td>
</tr>
<tr>
<td>4.6 - 4.7</td>
<td>35</td>
</tr>
<tr>
<td>4.4 - 4.5</td>
<td>16</td>
</tr>
<tr>
<td>4.2 - 4.3</td>
<td>9</td>
</tr>
<tr>
<td>4.0 - 4.1</td>
<td>9</td>
</tr>
<tr>
<td>3.8 - 3.9</td>
<td>8</td>
</tr>
<tr>
<td>3.6 - 3.7</td>
<td>3</td>
</tr>
<tr>
<td>3.4 - 3.5</td>
<td>0</td>
</tr>
<tr>
<td>3.2 - 3.3</td>
<td>1</td>
</tr>
</tbody>
</table>

N = 180
M = 4.9
SD = 0.4
will show that a few at the lower end were responsible for this, but that the great majority of the group fall between 18 and 46.

In preparing Tables V through VIII the following procedure was used. The total distributions of the Readiness Test scores, arithmetic achievement levels, and intelligent quotients were divided into three parts according to common practice: the highest twenty-seven per cent, the middle forty-six per cent, and the lowest twenty-seven per cent, within the limitations of the natural breaks in each distribution.

For the Readiness Test scores the highest twenty-seven per cent had scores of forty to forty-six and included thirty-two boys and eighteen girls. The middle forty-six per cent had scores of twenty-nine to thirty-nine and included thirty-seven boys and forty-five girls. The lowest twenty-seven per cent had scores from four to twenty-eight and included thirty-one boys and seventeen girls. For purposes of this study only the highest and lowest twenty-seven per cent were considered.

For the levels of arithmetic achievement the highest twenty-seven per cent ranged from 5.1 to 5.5; the middle forty-six per cent ranged from 4.6 to 5.0; the lowest twenty-seven per cent ranged from 3.1 to 4.5.
TABLE IV

DISTRIBUTION OF SCORES OF PUPILS ON READINESS TEST
FOR BEGINNING STUDY OF THE ADDITION OF FRACTIONS

<table>
<thead>
<tr>
<th>SCORES</th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 - 47</td>
<td>7</td>
</tr>
<tr>
<td>42 - 44</td>
<td>32</td>
</tr>
<tr>
<td>39 - 41</td>
<td>23</td>
</tr>
<tr>
<td>36 - 38</td>
<td>24</td>
</tr>
<tr>
<td>33 - 35</td>
<td>26</td>
</tr>
<tr>
<td>30 - 32</td>
<td>13</td>
</tr>
<tr>
<td>27 - 29</td>
<td>19</td>
</tr>
<tr>
<td>24 - 26</td>
<td>9</td>
</tr>
<tr>
<td>21 - 23</td>
<td>10</td>
</tr>
<tr>
<td>18 - 20</td>
<td>8</td>
</tr>
<tr>
<td>15 - 17</td>
<td>2</td>
</tr>
<tr>
<td>12 - 14</td>
<td>5</td>
</tr>
<tr>
<td>9 - 11</td>
<td>1</td>
</tr>
<tr>
<td>6 - 8</td>
<td>1</td>
</tr>
<tr>
<td>3 - 5</td>
<td>1</td>
</tr>
</tbody>
</table>

N = 180
M = 33.5
SD = 8.8
The highest twenty-seven per cent of the intelligence quotients was found to be between 110 and 137, the middle forty-six per cent between 90 and 109, and the lowest twenty-seven per cent between 68 and 89.

Table V shows the proportion of boys rated high on the Readiness Test for Beginning Study of the Addition of Fractions arranged according to their intelligence quotients and arithmetic achievement. Out of the forty-eight boys in the high I.Q. group, twenty-six of them, or 53 per cent, had high scores on the Readiness Test. Ten of the forty-eight, or 20 per cent, had high scores on the Readiness Test and had average achievement in arithmetic; sixteen of the forty-eight, or 33 per cent, had high scores on the Readiness Test and also had high achievement in arithmetic. There were no low achievers among those who had high I.Q.'s and scored high on the Readiness Test. Two of the forty boys in the average I.Q. group, or 5 per cent, rated high on the Readiness Test but had low achievement; two of the forty, or 5 per cent, had high scores on the Readiness Test but had average achievement; two of the forty, or 5 per cent, had high scores on the Readiness Test and had high achievement as well. Of the forty boys in the average I.Q. group, six of them, or 15 per cent, rated high on the Achievement Test. No one with an I.Q. below 90 made a high score on the test.
TABLE V

PROPORTION OF BOYS RATED HIGH ON READINESS TEST FOR BEGINNING STUDY OF ADDITION OF FRACTIONS ARRANGED ACCORDING TO INTELLIGENCE QUOTIENTS AND ARITHMETIC ACHIEVEMENT

<table>
<thead>
<tr>
<th>Arithmetic Achievement</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.Q. High</td>
<td>0/48</td>
<td>10/48</td>
<td>16/48</td>
</tr>
<tr>
<td>I.Q. Av.</td>
<td>2/40</td>
<td>2/40</td>
<td>2/40</td>
</tr>
<tr>
<td>I.Q. Low</td>
<td>0/12</td>
<td>0/12</td>
<td>0/12</td>
</tr>
</tbody>
</table>

| Total | 2   | 12   | 18   | 32   |
Table VI shows the proportion of boys rated low on the Readiness Test arranged according to intelligence quotients and arithmetic achievement. Of the forty-eight boys in the high I.Q. group, four of them, or 8 per cent, rated low on the Readiness Test. Two of the forty-eight, or 4 per cent, rated low on the Readiness Test and had low achievement; one of the forty-eight, or 2 per cent, had a low score on the Readiness Test and had average achievement; one of the forty-eight, or 2 per cent, had a low score in the Readiness Test and had high achievement. Of the forty boys in the average I.Q. group, eighteen of them, or 45 per cent, rated low on the Readiness Test. Seven of the forty, or 17 per cent, rated low on the Readiness Test and had low achievement; ten of the forty, or 25 per cent, rated low on the Readiness Test and had average achievement; one of the forty, or 2 per cent, rated low on the Readiness Test and had high achievement. Of the twelve boys in the low I.Q. group, nine of them, or 75 per cent, rated low on the Readiness Test. Five of the twelve, or 41 per cent, rated low on the Readiness Test and had low achievement; four of the twelve, or 33 per cent, rated low on the Readiness Test and had average achievement. No one with an intelligence quotient below 90 had high achievement in arithmetic.
TABLE VI

PROPORTION OF BOYS RATED LOW ON READINESS TEST FOR BEGINNING STUDY OF ADDITION OF FRACTIONS ARRANGED ACCORDING TO INTELLIGENCE QUOTIENTS AND ARITHMETIC ACHIEVEMENT

<table>
<thead>
<tr>
<th>Arithmetic Achievement</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>2/48</td>
<td>1/48</td>
<td>1/48</td>
</tr>
<tr>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Av. I.Q.</td>
<td>7/40</td>
<td>10/40</td>
<td>1/40</td>
</tr>
<tr>
<td>17%</td>
<td>25%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Low I.Q.</td>
<td>5/12</td>
<td>4/12</td>
<td>0/12</td>
</tr>
<tr>
<td>41%</td>
<td>33%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>15</td>
<td>2</td>
</tr>
</tbody>
</table>

Table VII shows the proportion of girls rated high on the Readiness Test for Beginning Study of the Addition of Fractions arranged according to intelligence quotients and arithmetic achievement. Of the forty-eight girls in the high I.Q. group, fifteen of them, or 31 per cent, rated high on the Readiness Test. None of the forty-eight rated high on the Readiness Test and had low achievement; eight of the forty-eight, or 16 per cent, rated high on the Readiness Test and had average achievement; seven of the forty-eight, or 14 per cent, rated high on the Readiness Test and had high achievement. Of the twenty-seven girls in the average I.Q. group, three of them, or 11 per cent, rated high on the Readiness Test. One of the twenty-seven, or 3 per cent, rated high on the Readiness Test and had low achievement; two of the twenty-seven, or 7 per cent, rated high on the Readiness Test and had average achievement; none of the twenty-seven rated high on the Readiness Test and had high achievement. None of the girls in the low intelligence group rated high on the Readiness Test.

Table VIII shows the proportion of girls rated low on the Readiness Test for Beginning Study of the Addition of Fractions arranged according to intelligence quotients and arithmetic achievement. Of the forty-eight girls in the high I.Q. group, five of them, or 10 per cent, rated low on
TABLE VII

PROPORTION OF GIRLS RATED HIGH ON READINESS TEST FOR BEGINNING STUDY OF ADDITION OF FRACTIONS ARRANGED ACCORDING TO INTELLIGENCE QUOTIENTS AND ARITHMETIC ACHIEVEMENT

<table>
<thead>
<tr>
<th>Arithmetic Achievement</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0/48</td>
<td>8/48</td>
<td>7/48</td>
</tr>
<tr>
<td>I.Q.</td>
<td>0%</td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>Av.</td>
<td>1/27</td>
<td>2/27</td>
<td>0/27</td>
</tr>
<tr>
<td>I.Q.</td>
<td>3%</td>
<td>7%</td>
<td>0%</td>
</tr>
<tr>
<td>Low</td>
<td>0/5</td>
<td>0/5</td>
<td>0/5</td>
</tr>
<tr>
<td>I.Q.</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

1, 10, 7, 18
TABLE VIII

PROPORTION OF GIRLS RATED LOW ON READINESS TEST FOR BEGINNING STUDY OF ADDITION OF FRACTIONS ARRANGED ACCORDING TO INTELLIGENCE QUOTIENTS AND ARITHMETIC ACHIEVEMENT

<table>
<thead>
<tr>
<th>Arithmetic Achievement</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/48</td>
<td>0%</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>6/27</td>
<td>22%</td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>3/5</td>
<td>60%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>I.Q. High</td>
<td>0/48</td>
<td>4/48</td>
<td>1/48</td>
</tr>
<tr>
<td>I.Q. Av.</td>
<td>6/27</td>
<td>3/27</td>
<td>0/27</td>
</tr>
<tr>
<td>I.Q. Low</td>
<td>3/5</td>
<td>0/5</td>
<td>0/5</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
the Readiness Test. None of the forty-eight rated low on the Readiness Test and low in achievement; four of the forty-eight, or 8 per cent, rated low on the Readiness Test and had average achievement; one of the forty-eight, or 2 per cent, rated low on the Readiness Test and had high achievement.

Of the twenty-seven girls in the average I. Q. group, nine of them, or 33 per cent, rated low on the Readiness Test. Six of the twenty-seven, or 22 per cent, rated low on the Readiness Test and had low achievement; three of the twenty-seven, or 11 per cent, rated low on the Readiness Test and had average achievement; none of the twenty-seven rated low on the Readiness Test and had high achievement. Of the five in the low I. Q. group, three of them, or 60 per cent, rated low on the Readiness Test. These same three, or 60 per cent, rated low on the Readiness Test and had low arithmetic achievement; none of the five who rated low on the Readiness Test had average or high achievement.

In the comparison of Table V with Table VII and Table VI with Table VIII there does show some difference between the boys and girls which may merit further investigation. Of the boys and girls in the high I.Q. group, 33 per cent of the boys who had high scores on the Readiness Test were also in the high achieving group as compared with 14% of the girls. Of the boys and girls who rated low on the Test
and were in the low I.Q. group, 41 per cent of the boys were low achievers as compared with 60 per cent of the girls. There seems to be a tendency for a greater proportion of the boys to have high scores on the Readiness Test and to be higher achievers than the girls. However, this is an area which should be explored further.

Table IX gives an analysis of the test items showing the per cent getting each item correct in the High Score Group, the Low Score Group, and the Total Group. In Part I items 1a to 1f all discriminated between those in the High Score Group and those in the Low Score Group, but not markedly so. In writing the fractions in numbers from words, 100 per cent of the High Score Group had them all correct with the exception of 1f which was written correctly by 96 per cent of this group. In the Low Score Group about 85 per cent of them answered it correctly. Although 90 per cent of the Total Group were able to write fractions correctly when given the fraction in words, the ability to do this is a very important part of readiness for fractions and, therefore, these items should not be omitted. In items 2a to 2d there was more of a distinction between the two groups, 2a and 2d showing the most discrimination.

In Part II items 1c, 1d, 1e, 3b, and 3d showed a marked discrimination between those in the two groups. Items
lb, 2c, 2d, 2e, and 3c showed some discrimination, although not as marked. Item la showed no discrimination since all of the Low Score Group and the High Score Group as well as 99 per cent of the Total Group were able to divide the square into fourths. However, this item should be retained since the ability to divide a square into fourths is a very definite part of readiness. Only 90 per cent of the High Score Group, 70 per cent of the Low Score Group, and 81 per cent of the Total Group were able to divide a rectangle into fourths. Apparently the shape of the geometric figure had something to do with their understanding of the concept.

In item 1c, which asked for three-eighths of the circle to be colored, 96 per cent of the High Score Group, 41 per cent of the Low Score Group, and 71 per cent of the Total Group did this correctly. This involved dividing the circle into eighths first, which was not done by those who made incorrect drawings. This item clearly had a good level of discrimination.

Item 1d, which asked what part of the circle would not be colored, was answered correctly by 88 per cent of the High Score Group, 20 per cent of the Low Score Group, and 57 per cent of the Total Group. This showed a definite need for better understanding of the concept of eighths on the part of the Low Score Group. The level of discrimination was
good in this item.

Item le, which called for a knowledge of two-thirds
discriminated markedly between the two groups since 94 per
cent of the High Score Group had it right as compared with
20 per cent of the Low Score Group. This showed a need for
a better understanding of thirds on the part of the Low
Score Group.

Item 1f, closely related to le, discriminated very
markedly between the two groups since 16 per cent of the Low
Score Group were able to answer the item correctly as com­
pared with 94 per cent of the High Score Group.

The next series of items, 2a to 2e, which involved
recognition of fractional parts of circles, showed some dis­
crimination but not to any great degree. Item 2c, which
dealt with sixths, showed the most discrimination since only
62 per cent of the Low Score Group had this right as com­
pared with 98 per cent of the High Score Group. Item 2d,
which asked which circle was divided into quarters, showed
a little less discrimination since 66 per cent of the Low
Score Group answered this item correctly. Apparently the
difficulty was in the understanding of the word "quarters".
Item 2c was not quite as discriminatory since 70 per cent
of the Low Score Group were able to tell how many thirds
in a whole circle.

Items 3a to 3d all showed some discrimination between the two groups. Of these items, 3d, which showed a circle with one-third of it missing and asked what part of the circle was left, showed the most marked discrimination since only 18 per cent of the Low Score Group answered that correctly, whereas 94 per cent of the High Score Group had it right. Item 3b, which showed a circle divided into sixths, one sixth of which was colored, was answered correctly by 50 per cent of the Low Score Group while 98 per cent of the High Score Group had it right. Item 3a, which showed three-fourths of a circle left and asked what part of the circle was missing, was answered correctly by 60 per cent of the Low Score Group while 98 per cent of the High Score Group had it right.

In Part III all items showed discrimination. However, item one proved too difficult for both groups since only 18 per cent of the High Score Group as well as 10 per cent of the Low Score Group had it right. It consisted of four geometric figures each one of which was divided into four parts only two of which were divided into fourths. In order to get credit for his answer the pupil had to circle the two figures which were divided into fourths. One fig-
ure was a square divided into fourths in an unusual manner. This figure was the one responsible for the most errors. Very few recognized that this figure was divided into fourths.

Item two discriminated between the two groups since 74 per cent of the High Score Group were able to correctly circle the figures which were divided into thirds while only 20 per cent of the Low Score Group had it right. Item three showed marked discrimination between the groups since 98 per cent of the High Score Group were able to color five eighths of the rectangle correctly while only 22 per cent of the Low Score Group did it correctly. Of the first five items in Part III, item four, which asked what part of the figure in item three would not be colored, showed the greatest amount of discrimination since 94 per cent of the High Score Group answered it correctly whereas only 8 per cent of the Low Score Group had it right. Item five was answered correctly by 100 per cent of the High Score Group while 60 per cent of the Low Score Group had it right.

Items six to eleven which tested the concept of fractional parts of a group showed great discrimination between the two groups although item six proved to be difficult for some of the High Score Group, too, since only 54 per cent of them had this right as compared to 6 per cent of
the Low Score Group. Item seven showed marked discrimination since 98 per cent of the High Score Group had it right whereas only 10 per cent of the Low Score Group answered this correctly. Item eight proved to be difficult for the Low Score Group since only 16 per cent of this group were able to answer it correctly while 98 per cent of the High Score Group had it right. Items nine and ten showed great discrimination since 98 per cent of the High Score Group had it correct as compared with 52 per cent of the Low Score Group.

Items twelve to fifteen showed marked discrimination. Item twelve was answered correctly by 94 per cent of the High Score Group while only 14 per cent of the Low Score Group had it right. Item thirteen was answered correctly by 98 per cent of the High Score Group but only 20 per cent of the Low Score Group could do this one. Items fourteen and fifteen discriminated greatly since none of the Low Score Group did either correctly while 74 and 76 per cent of the High Score Group answered correctly.

In Part IV all items, with the exception of item five, showed a marked discrimination between the two groups. Even item five showed some discrimination. Item one tested addition of like things. Of the High Score Group, 52 per cent answered this one correctly while only 10 per cent of
the Low Score Group did so. In item two 80 per cent of the High Score Group were able to tell what the numerator of a fraction meant and in item three 72 per cent of the High Score Group could tell what the denominator of a fraction meant. Only 35 per cent and 25 per cent of the Low Score Group were able to answer correctly items one and two respectively.

Items four, five, and six were understood by 96 per cent of the High Score Group but by only 66 per cent, 62 per cent, and 39 per cent of the Low Score Group. Item seven was answered correctly by 72 per cent of the High Score Group but only 27 per cent of the Low Score Group did this one correctly.

In Part V, which was not used for scoring purposes, no one was able to do items two, three, and four, indicating that probably none of these children had had any formal instruction in the addition of fractions. There were some who answered item one correctly.

The product-moment coefficient of correlation between the chronological ages of the children and the scores on the Readiness Test for Beginning Study of the Addition of Fractions was found to be -.244 which shows very little correlation and negative but still is statistically significant. This indicates a very slight tendency toward older children
making lower scores. This is understandable because the older children were found to be the repeaters.

The product-moment coefficient of correlation between the local grade scores of the arithmetic sub-tests from the Metropolitan Achievement Test and the scores on the Readiness Test was found to be +.522 which showed a trend for those who were high achievers in arithmetic to be high scorers on the Readiness Test.

The product-moment coefficient of correlation between the intelligence quotients derived from the Kuhlmann-Anderson Intelligence Test and the scores on the Readiness Test was found to be +.581 which again is a trend toward those who were in the high I.Q. classification to be high scorers on the Readiness Test.

However, none of the coefficients is of sufficiently large magnitude to have much value for predictive purposes as far as individual children are concerned.
TABLE IX

ANALYSIS OF TEST ITEMS SHOWING PER CENT GETTING EACH ITEM CORRECT IN THE HIGH SCORE GROUP, THE LOW SCORE GROUP, AND THE TOTAL GROUP

PART I

<table>
<thead>
<tr>
<th>ITEM</th>
<th>HIGH</th>
<th>LOW</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>100</td>
<td>89</td>
<td>97</td>
</tr>
<tr>
<td>1b</td>
<td>100</td>
<td>85</td>
<td>96</td>
</tr>
<tr>
<td>1c</td>
<td>100</td>
<td>89</td>
<td>91</td>
</tr>
<tr>
<td>1d</td>
<td>100</td>
<td>83</td>
<td>90</td>
</tr>
<tr>
<td>1e</td>
<td>100</td>
<td>87</td>
<td>96</td>
</tr>
<tr>
<td>1f</td>
<td>96</td>
<td>83</td>
<td>93</td>
</tr>
<tr>
<td>2a</td>
<td>98</td>
<td>54</td>
<td>77</td>
</tr>
<tr>
<td>2b</td>
<td>100</td>
<td>66</td>
<td>89</td>
</tr>
<tr>
<td>2c</td>
<td>100</td>
<td>66</td>
<td>89</td>
</tr>
<tr>
<td>2d</td>
<td>98</td>
<td>58</td>
<td>82</td>
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</tbody>
</table>

PART II

<table>
<thead>
<tr>
<th>ITEM</th>
<th>HIGH</th>
<th>LOW</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>100</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>1b</td>
<td>90</td>
<td>70</td>
<td>81</td>
</tr>
<tr>
<td>1c</td>
<td>96</td>
<td>41</td>
<td>71</td>
</tr>
<tr>
<td>1d</td>
<td>88</td>
<td>20</td>
<td>57</td>
</tr>
<tr>
<td>1e</td>
<td>88</td>
<td>16</td>
<td>61</td>
</tr>
<tr>
<td>1f</td>
<td>94</td>
<td>20</td>
<td>62</td>
</tr>
</tbody>
</table>
TABLE IX (continued)

ANALYSIS OF TEST ITEMS SHOWING PER CENT GETTING EACH ITEM CORRECT IN THE HIGH SCORE GROUP, THE LOW SCORE GROUP, AND THE TOTAL GROUP

PART II (continued)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>HIGH</th>
<th>LOW</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2a</td>
<td>98</td>
<td>89</td>
<td>95</td>
</tr>
<tr>
<td>2b</td>
<td>100</td>
<td>95</td>
<td>98</td>
</tr>
<tr>
<td>2c</td>
<td>98</td>
<td>62</td>
<td>82</td>
</tr>
<tr>
<td>2d</td>
<td>100</td>
<td>66</td>
<td>86</td>
</tr>
<tr>
<td>2e</td>
<td>100</td>
<td>70</td>
<td>86</td>
</tr>
<tr>
<td>3a</td>
<td>98</td>
<td>60</td>
<td>81</td>
</tr>
<tr>
<td>3b</td>
<td>98</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>3c</td>
<td>100</td>
<td>79</td>
<td>92</td>
</tr>
<tr>
<td>3d</td>
<td>94</td>
<td>18</td>
<td>58</td>
</tr>
</tbody>
</table>

PART III

1. 18   10   12
2. 74   20   41
3. 98   22   64
4. 94   8    58
5. 100  60   86
6. 54   6    29
7. 98   10   63
8. 98   16   68
9. 98   14   61
TABLE IX (continued)

ANALYSIS OF TEST ITEMS SHOWING PER CENT GETTING EACH
ITEM CORRECT IN THE HIGH SCORE GROUP, THE LOW SCORE GROUP,
AND THE TOTAL GROUP

PART III (continued)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>HIGH</th>
<th>LOW</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>94</td>
<td>12</td>
<td>57</td>
</tr>
<tr>
<td>11.</td>
<td>98</td>
<td>52</td>
<td>78</td>
</tr>
<tr>
<td>12.</td>
<td>94</td>
<td>14</td>
<td>61</td>
</tr>
<tr>
<td>13.</td>
<td>98</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>14.</td>
<td>74</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>15.</td>
<td>76</td>
<td>0</td>
<td>28</td>
</tr>
</tbody>
</table>

PART IV

<table>
<thead>
<tr>
<th></th>
<th>HIGH</th>
<th>LOW</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>52</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>2.</td>
<td>80</td>
<td>35</td>
<td>55</td>
</tr>
<tr>
<td>3.</td>
<td>72</td>
<td>25</td>
<td>47</td>
</tr>
<tr>
<td>4.</td>
<td>96</td>
<td>39</td>
<td>70</td>
</tr>
<tr>
<td>5.</td>
<td>96</td>
<td>62</td>
<td>80</td>
</tr>
<tr>
<td>6.</td>
<td>96</td>
<td>39</td>
<td>70</td>
</tr>
<tr>
<td>7.</td>
<td>72</td>
<td>27</td>
<td>62</td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of the study was to construct and analyze a test to determine readiness for beginning the study of addition of fractions. Before constructing the items of the test it was necessary to set up the underlying concepts and understandings upon which readiness for fractions seems to depend. This represents the original test with suggestions for revision.

The test was administered in December, 1951, to six fifth-grade classes in three different schools located in the same community. This group, composed of one hundred boys and eighty girls, was found to be about average chronologically, but above average in intelligence and arithmetic achievement in terms of national norms.

CONCLUSIONS

1. Most of the items of the test showed discrimination.

2. Those items which didn't show discrimination should be retained because of the nature of a readiness test in which each item represents a requisite ability to be tested. Possibly the non-discriminatory items should be recast
to make them more discriminatory.

3. In a revision of the test the writer would change the order of items in Part II. Items 2a - 2d should come before items 1a - 1f, since it is harder to reproduce than it is to identify. Also, in Part III, item one proved to be too difficult for both the high and the low group. Therefore, it is suggested that the second geometric figure be changed since this one caused the greatest difficulty. A square divided diagonally could be substituted for this figure.

4. Generally speaking, those boys and girls who rated high on the Readiness Test for Beginning Study of the Addition of Fractions were also in the high I.Q. group. However, of the one hundred boys, thirty-two per cent rated high on the Readiness Test as compared with twenty-two per cent of the eighty girls.

5. Of the one hundred boys, twelve, or twelve per cent, were low in intelligence as compared with six per cent of the girls. However, of those low in intelligence and low on the Readiness Test, forty-one per cent of the boys were also low achievers as compared with six per cent of the girls.

6. Statements three and four indicate a tendency toward a sex difference which should merit further study.
7. The product-moment coefficient of correlation between the chronological ages of the children and their scores on the Readiness Test was found to be -.244 which shows very little correlation and negative. This indicates a very slight tendency for older children to make lower scores. This is understandable because the older children were generally found to be the repeaters.

8. The product-moment coefficient of correlation between the intelligent quotients obtained from the Kuhlmann-Anderson Intelligence Test and the scores on the Readiness Test was found to be +.581 which is a trend toward those who were in the higher I.Q. classifications to be high scorers on the Readiness Test.

9. The product-moment coefficient of correlation between the local grade scores of the arithmetic sub-tests of the Metropolitan Achievement Test and the scores on the Readiness Test was found to be +.522 which shows a trend for those who were high achievers in arithmetic to be high scorers on the Readiness Test.

10. The teachers who gave this test were very enthusiastic about it and felt that any child who did not score well on the test was not ready for formal fraction work. They agreed that the test certainly showed individual as well as class weaknesses. The test, in their opinion, ful-
filled its purpose in that it determined whether or not the children were ready for formal work in fractions.

LIMITATIONS OF THE STUDY

1. There was no opportunity to validate the test for predictive purposes since all children who did not do well were given more help before being introduced to formal fractions.

2. Although each item in the test had face validity, it was not subjected to thorough statistical validations.

3. The total raw score was obtained by adding the part scores which, therefore, assigns greater weight to those parts of the test which have the greatest number of items.

4. The group tested may not have been sufficient and varied in number. Any conclusions which may be drawn should be interpreted in the light of the fact that this group was found to be above average in intelligence.

5. The items in each part of the test may not have been sufficient in all cases to measure readiness reliably.

6. The abilities measured may not have been all-inclusive of readiness.
SUGGESTIONS FOR FURTHER STUDY

1. A revision of the test could be made embodying the suggestions set forth in this chapter.

2. The test could be validated for its predictive value.

3. Sex differences could be explored further.

4. The revised test could be administered to a greater number of classes and communities.

5. The optimum weight that should be assigned to each part of the test in determining readiness could be worked out and the raw scores set up accordingly.
BIBLIOGRAPHY


READINESS TEST FOR BEGINNING STUDY OF THE ADDITION OF FRACTIONS

Part I

1. Write these fractions using numbers:
   a. One third __
   b. One half __
   c. One fourth __
   d. Five sixths __
   e. Three fourths __
   f. Eleven sixteenths __

2. a. \( \frac{3}{10} \) ______
   b. \( \frac{3}{8} \) ______
   c. \( \frac{1}{6} \) ______
   d. \( \frac{7}{8} \) ______

Part II

1. a. Divide this square into fourths.
   
   b. Divide this figure into fourths.

   c. Color three eighths of this circle with your pencil. You may draw in any lines you need.

   d. What part of the circle will not be colored?

   e. Color two thirds of this circle with your pencil. You may draw in any lines you need.

   f. What part of the circle will not be colored?
2. 

a. Which circle is divided into halves? _____
b. Which circle is divided into sixths? _____
c. How many sixths are there in a whole circle? _____
d. Which circle is divided into quarters? _____
e. How many thirds are there in a whole circle? _____

3. 

a. What part of circle A is missing? _______________
b. What part of circle B is colored? _______________
c. What part of circle C is gone? _______________
d. What part of circle D is left? _______________

Part III

1. One or more of these figures is divided into fourths. Circle the figure or figures showing fourths.
2. One or more of these figures is divided into thirds. Circle the figure or figures that show thirds.

3. Color five eighths of this figure with your pencil.

4. What part of this figure will not be colored? __________

5. What part of this figure is colored? __________

6. Color \( \frac{1}{3} \) of this group of triangles with your pencil.

7. What fractional part of the group of squares is colored? __________

8. What fractional part of the group of squares is not colored? __________
9. What fractional part of the blanks has no crosses?

\[ \underline{X \ X \ X \ X \ X \ X \ X} \]

10. What fractional part of the above blanks has crosses?

\[ \underline{\bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc} \]

11. Color \( \frac{4}{9} \) of the balls with your pencil.

12. What fractional part of the balls is not colored?

13. What part of this figure is colored?

14. Circle the pairs of fractions which are equal in value or size.
   a. \( \frac{1}{4}, \frac{2}{8} \)  b. \( \frac{2}{3}, \frac{3}{4} \)  c. \( \frac{1}{2}, \frac{4}{8} \)

15. Circle the larger fraction in each of these pairs of fractions.
   a. \( \frac{1}{4}, \frac{1}{2} \)  b. \( \frac{1}{3}, \frac{1}{6} \)  c. \( \frac{3}{4}, \frac{1}{2} \)
Part IV

1. Some of these things can be added without changing them. Circle the letter in front of the ones which can be added without changes.

a. 3 cups + 2 saucers + 5 platters
b. 8 children + 3 children + 9 children
c. 3 dishes + 2 dishes + 5 dishes
d. 5 boys + 3 girls + 9 babies
e. 5 animals + 6 animals + 2 animals + 3 animals
f. 5 goats + 6 sheep + 2 cows + 3 horses

2. In the fraction \( \frac{3}{4} \) the 3 tells ____________
   a. the size of the parts       b. the number of parts

3. In the fraction \( \frac{8}{9} \) the 8 tells ____________
   a. the size of the parts       b. the number of parts

4. 2 parts + 2 parts + 1 part = ___ parts

5. 1 fourth + 2 fourths + 3 fourths = ___ fourths

6. \( \frac{1}{4} + \frac{1}{4} + \frac{1}{4} = ___ \)

7. \( \frac{7}{8} + \frac{1}{8} + \frac{2}{8} + \frac{3}{8} = ___ \)

Part V

Here are some examples you can try to do. You are not expected to know how to do them. It would be interesting to see if you can work out the answers.

1. \( \frac{1}{2} + \frac{1}{4} = ___ \) 3. \( \frac{1}{2} + \frac{1}{3} = ___ \)

2. \( \frac{1}{2} + \frac{3}{6} = ___ \) 4. \( \frac{1}{3} + \frac{3}{4} = ___ \)
READINESS TEST FOR BEGINNING STUDY OF THE ADDITION OF FRACTIONS
Give one point for each correct answer.

Part I (10 points)

1. Write these fractions using numbers:
   (a) One third \( \frac{1}{3} \)
   (b) One half \( \frac{1}{2} \)
   (c) One fourth \( \frac{1}{4} \)
   (d) Five sixths \( \frac{5}{6} \)
   (e) Three fourths \( \frac{3}{4} \)
   (f) Eleven sixteenths \( \frac{11}{16} \)

   2. a. \( \frac{3}{10} \) three tenths
   b. \( \frac{2}{3} \) two thirds

Part II (15 points)

1. a. Divide this square into fourths. Give credit for any of the three ways of dividing the square. Include dividing the square diagonally.

   b. Divide this figure into fourths. Give credit as in la. No credit, however, for dividing the rectangle diagonally.

   c. Color three eighths of this circle with your pencil. You may draw in any lines you need.

   d. What part of the circle will not be colored? \( \frac{5}{8} \)

   e. Color two thirds of this circle with your pencil. You may draw in any lines you need.

   f. What part of the circle will not be colored? \( \frac{1}{3} \)
(1) a. Which circle is divided into halves?  D
(1) b. Which circle is divided into sixths?  C
(1) c. How many sixths are there in a whole circle?  six
(1) d. Which circle is divided into quarters?  B
(1) e. How many thirds are there in a whole circle?  three

(1) a. What part of circle A is missing?  \( \frac{1}{4} \) or one fourth
(1) b. What part of circle B is colored?  \( \frac{1}{6} \) or one sixth
(1) c. What part of circle C is gone?  \( \frac{1}{2} \) or one half
(1) d. What part of circle D is left?  \( \frac{2}{3} \) or two thirds

Part III (15 points)

(1) 1. One or more of these figures is divided into fourths. Circle the figure or figures showing fourths.

To get credit both figure two and four must be circled.
3. One or more of these figures is divided into thirds. Circle the figure or figures that show thirds. To get credit figure one and three must be circled.

3. Color five eighths of this figure with your pencil.

4. What part of this figure will not be colored? \( \frac{3}{8} \)

5. What part of this figure is colored? \( \frac{2}{4} \) or \( \frac{1}{2} \)

6. Color \( \frac{1}{3} \) of this group of triangles with your pencil.

7. What fractional part of the group of squares is colored? \( \frac{5}{6} \)

8. What fractional part of the group of squares is not colored? \( \frac{1}{6} \)
(1) 9. What fractional part of the blanks has no crosses? \( \frac{3}{10} \)

\[ \begin{array}{cccccc}
\times & \times & \times & \times & \times & \times \\
\end{array} \]

(1) 10. What fractional part of the above blanks has crosses? \( \frac{7}{10} \)

(1) 11. Color \( \frac{4}{9} \) of the balls with your pencil.

(1) 12. What fractional part of the balls is not colored? \( \frac{5}{9} \)

(1) 13. What part of this figure is colored? \( \frac{5}{12} \)

(1) 14. Circle the pairs of fractions which are equal in value or size.

- a. \( \frac{1}{2}, \frac{2}{3} \)
- b. \( \frac{2}{3}, \frac{3}{4} \)
- c. \( \frac{1}{2}, \frac{1}{3} \)

(1) 15. Circle the larger fraction in each of these pairs of fractions.

- a. \( \frac{1}{4}, \frac{1}{2} \)
- b. \( \frac{1}{3}, \frac{1}{6} \)
- c. \( \frac{3}{4}, \frac{1}{2} \)
Part IV  (7 points)

(1) 1. Some of these things can be added without changing them. Circle the letter in front of the ones which can be added without changes.

a. 3 cups $+$ 2 saucers $+$ 5 platters
b. 9 children $+$ 3 children $+$ 9 children
c. 5 dishes $+$ 2 dishes $+$ 5 dishes
d. 3 boys $+$ 3 girls $+$ 9 babies
e. 5 animals $+$ 6 animals $+$ 2 animals $+$ 3 animals
f. 5 goats $+$ 6 sheep $+$ 2 cows $+$ 3 horses

(1) 2. In the fraction $\frac{3}{4}$ the 3 tells

a. the size of the parts  \hspace{1cm} b. the number of parts

(1) 3. In the fraction $\frac{5}{3}$ the 8 tells

a. the size of the parts  \hspace{1cm} b. the number of parts

(1) 4. $2 \text{ parts} + 2 \text{ parts} + 1 \text{ part} = \underline{5} \text{ parts}$

(1) 5. $1 \text{ fourth} + 2 \text{ fourths} + 3 \text{ fourths} = \underline{6} \text{ fourths}$

(1) 6. \[
\begin{array}{c}
\frac{1}{4} + \frac{1}{4} + \frac{1}{4} = \frac{3}{4}
\end{array}
\]

(1) 7. \[
\frac{1}{8} + \frac{1}{8} + \frac{2}{8} + \frac{3}{8} = \frac{7}{8}
\]

Part V

Here are some examples you can try to do. You are not expected to know how to do them. It would be interesting to see if you can work out the answers.

1. \[
\frac{1}{3} + \frac{1}{4} = \frac{3}{4}
\]

3. \[
\frac{1}{2} + \frac{1}{3} = \frac{5}{6}
\]

2. \[
\frac{1}{2} \div \frac{3}{8} = \frac{7}{8}
\]

4. \[
\frac{1}{6} \div \frac{3}{8} = \frac{7}{8}
\]