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Identification and Measurement of the Arithmetical Concepts and Abilities of Pre-School and Primary Grade School Children

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I. INTRODUCTION

A recent trend in elementary education has been the development of readiness programs. Reading readiness programs have proved their value and have been widely accepted by most educators. Programs of readiness for arithmetic are considered to be similarly important, but are developing more slowly.

An arithmetic readiness program requires some method of measuring a child's level of competence in numerical skills and abilities prior to the introduction of teaching arithmetic. No satisfactory instrument has been constructed and standardized for use with children varying from the pre-school to the second-grade level. The primary purpose of this investigation was to construct and standardize a test of arithmetical skills and abilities for use with children from the pre-school to the second-grade level.

II. METHODS AND PROCEDURE

A. *Preliminary steps*

Because of the immaturity of the children at the low educational levels, an individually administered instrument was constructed. To increase the feasability of the test, items requiring only the test blank and pencil as materials were considered. A preliminary form consisting of 300 items was constructed. Some of these items were original and others were collected from an examination of courses of study, teaching materials, arithmetic workbooks, etc. The items selected sampled a number of different numerical skills and abilities including, counting objects, number matching, number writing, knowledge of fractional parts, number recognition, ordinal and cardinal concepts, number series completion, number word recognition, knowledge of common measures, and ability to do simple computations.

The preliminary test was administered to 96 white children equally divided into the four grade levels and by sex. An effort was made to obtain a wide range of intellectual ability within each grade level. The pre-school group was limited to those children who

would enter kindergarten at the beginning of the next school year.

Following the pre-testing a complete analysis of the pre-test was made. The items selected for the final test were those showing an increase in the percentage of correct responses as the grade levels increased; those differentiating between the upper fifty and lower fifty per cent of one or more grade levels; and those which had administrative instructions that were readily understood by the testees. The similar items measuring a particular numerical ability were placed in increasing order of difficulty.

B. *Standardizing Testing.*

The final form of the test containing 180 items was standardized on a group of 400 white children and among the four grade levels evenly divided by sex.

The 100 cases in each grade were stratified according to the size of the community and occupational level of the subject's fathers. Close agreement with census data for Nebraska was attained on both of these factors.

C. *Post-standardization Analyses*

1. Homogeneity.
   The items were arbitrarily grouped into four areas according to the numerical ability they appeared to measure. These four areas are described as follows: Area I pertained to counting and number concepts; Area II pertained to number and number-word recognition and number writing; Area III pertained to simple computation; Area IV pertained to general numerical information such as knowledge of common measures, money, etc.
   Separate scores by area were determined and this data subjected to a test of homogeneity (Neidt) to determine whether the areas were sufficiently dissimilar to warrant obtaining a separate score for each area in addition to a total score.
2. Reliability
   Spearman-Brown and Kuder-Richardson reliability coefficients were obtained for the total test and for each area by grade level.
3. Validity
   Increasing mean scores for the total test and for each area as the grade levels increased and increasing percentage of correct responses to separate items as grade-level means were taken as indications of validity.
4. Sex Differences
   The mean scores by grade level for each sex for the total test and for each area were determined and sex differences in each instance were examined.
5. Urban-Rural Difference
   The mean scores by grade level for urban and rural groups for the total test and for each area were determined and differences in each instance were examined.

6. Father's Occupational Level
A coefficient of correlation was computed between father's occupational level and total test scores within each grade level.

III. Results

A. *Test Homogeneity*

Only between Areas I and IV did there appear to be homogeneity from a statistical standpoint. Areas IV items were therefore added to Area I. The three remaining areas were considered to be sufficiently non-homogenous to warrant obtaining separate scores for each.

C. *Reliability*

The Spearman-Brown reliabilities for the areas by grade levels ranged from .821 to .978, and Kuder-Richardson reliabilities ranged from .742 to .957.

D. *Validity*

Increasing mean scores for each area as the grade levels increased were obtained. Only three of the 180 items failed to show an increasing percentage of correct responses between two or more grade levels.

E. *Sex Differences*

A statistically significant difference was found between the Area II scores of the second-grade group, the females having the advantage. The females also made higher, but not statistically significant, scores in Area II in the other three grade levels.

F. *Urban-Rural Differences*

In all test areas at the first-grade level the differences were highly significant statistically in favor of the rural group. A statistically significant difference was also found in Area II at the kindergarten level in favor of the rural group.

The rural children made higher mean scores on all areas on the top three grade groups. In the pre-school group, however, the urban group was higher in all areas.

G. *Father's Occupational Level*

The occupational levels were numbered as they appeared on the Dictionary of Occupations, titles with the highest occupational level having the lowest number and with the occupational levels numbered in this manner negative correlations were found between test scores and father's occupational level. The correlation was statistically significant only at the second-grade level.

IV. Discussion

A. *Reliability*

Several conditions in the construction of the test were felt to have contributed to the high reliabilities obtained. One factor was the similarity of items within groups of items measuring the same ability. For example, the ability to count five objects is obviously highly related to the ability to count eight objects. The odd-even division of the test would thus yield very similar halves.

Other contributing factors were the placement of items in an increasing order of difficulty, the individual administration of the test which allows more control, the objectivity of the test items, and the test length of 180 items.

B. *Sex Differences*

Success in Area II appeared to depend upon the subject's skill in verbal tasks. The apparent female superiority at all grade levels in Area II seems to agree with the findings of numerous other investigations which have indicated a female superiority on verbal tasks.

C. *Urban-Rural Differences*

It was felt that two important factors explain the consistent advantage of the rural groups in the upper three grade levels. One factor was the longer daily sessions of most of the rural kindergartens and the other was the combination of two or more primary grade classes which occurred in most of the rural schools. The rural children in this sample were thus exposed to numbers earlier than urban children.

D. *Father's Occupational Level*

The direct relationship found between father's occupational level and total test scores is believed to be mostly due to the factor of intelligence. Numerous investigations have found a direct relationship between intelligence and socio-economic level.

To attempt an explanation of the significant relationship which was found only in the second-grade group it may be hypothesized that the second grade, in which more complex arithmetical abilities are taught, is the point where the more able children begin to be differentiated from the less able in number ability.

V. Conclusions

The large individual differences found in all four age groups investigated emphasizes the importance of a readiness program in arithmetic.

It is felt that the instrument here developed will be of value to an arithmetic readiness program in the primary grades.

Literature Cited

Neidt, C. O. Technique for Testing the Homogeneity of Separately-Evaluated Behavior Characteristics. Iowa State Journal of Science, 1949, 90-92.

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