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Some Relationships Between IQ And Arithmetic Achievement For Selected Junior High School Students

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SOME RELATIONSHIPS BETWEEN IQ AND ARITHMETIC ACHIEVEMENT FOR SELECTED JUNIOR HIGH SCHOOL STUDENTS

A Problem Submitted to the Department of Education in Partial Fulfillment of the Requirements for the Course in Research Problems 390b

By

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INTRODUCTION

The ever-increasing complexity of today's highly dynamic society demands that the educator of our nation's children be always in search of knowledge that will enable him to comprehensively understand the actions, attitudes, and abilities of his students. With this view in mind, the author is attempting to set down the results of his research.

Caswell (4:v) has stated that too little educational practice is based on research. The greatest influence on the teaching practices of too many teachers is still the methods by which they themselves were taught. One of the fundamental needs in strengthening education is the development of a more adequate research basis.

Statement of the Problem

The problem of this study was to determine the correlation between various characteristics of some of the Junior High School students of Atchison, Kansas. Each of the students involved were given three arithmetic achievement tests and an intelligence test. The results of the various tests were then compared in such a manner as to determine the degree of correlation existing between those results.

Purpose of the Study

There are many values to be obtained from a study of this nature. In thinking through and carrying out this study, the author hoped to obtain the following: (1) additional information concerning the student, (2) a better evaluation of the instructors' methods of teaching, (3) more knowledge of possible underachievers and overachievers, (4) information that may point out possible strengths and weaknesses of the teacher's presentation and analysis of pupil's progress, (5) factual material to be inserted in the student's accumulative records that will be an aid to other teachers of the students, (6) an evaluation of abilities for guidance purposes, and (7) the amount of educational growth made during the year.

Research Design

There are four major research tools by which one may hope to attack and solve research problems. (41)

1. Documentary or historical
2. Survey
3. Case Study
4. Experiment

This study utilized the first two of these tools--the documentary method and the survey method.

The Documentary Method. The use of this tool involves

delving into the library in search of information related to the problem being considered.

In their book on the methodology of research, Good, Barr, and Scates (6:250-264) break the historical method of research into three major processes. They are:

(1). Collection of data.

(2). Criticism of data collected.

(3). The presentation of the facts.

In the pursuit of collecting data related to the problems at hand, one must make use of the various materials to be found in the library.

Library materials may be grouped under such classifications as books, periodicals, documents, manuscripts, pamphlets, pictures, clippings, films, maps, or leaflets. These in turn are classified by authors, titles, and subjects. (1:4)

Guides used to locate the above materials include (1) card catalog, (2) periodical indexes, (3) educational index, (4) bibliography listings, (5) reference books, (6) publications of educational associations, (7) United States Office of Education publications, and (8) Government documents. (1:58)

The librarian can also be very helpful in directing the researcher to information related to his problem.

In criticizing and evaluating the documentary material, not only the reliability of the material should

be judged, but also the authenticity of the author. Attention should be given to the factors that may have influenced the writing of the material and any biases and prejudices of the author.

Good, Barr, and Scates (6:104-05) list five purposes for searching for previous studies, discussions, and experiences relating to the problem under investigation.

> 1. Show whether the evidence already available solves the problem adequately without further investigation;
>
> 2. provide ideas, theories, explanations, or hypotheses valuable in formulating the problem;
>
> 3. suggest methods of research appropriate to the solution of the problem;
>
> 4. locate comparative data useful in the interpretation of results; and
>
> 5. contribute to the general scholarship of the investigator.

Some advantages in the use of the documentary method research follows. (1) Use of the materials at hand incurs less expense. (2) Most of the documentary materials are located in a centralized place, the library, and are thus easily accessible to the researcher. (3) The researcher can obtain information that may not be available to him through other methods of research. (4) Most investigators are already familiar with at least a few of the procedures for obtaining information from the library.

The disadvantages of this method are to be considered. (1) Documentary research is very time consuming. (2) The

research novice will have difficulty in analyzing, evaluating, and interpreting the data after he has procured it. (3) Authenticity of the author is often difficult to establish. (4) The swiftly changing world often outdates material that was valid at the time it was set down. (5) Much of the material, when found, will not be applicable to the problem under consideration. (6) The amateur researcher probably will not have developed a system of note taking and thus will waste time on trial and error systems or in relocating the material. (6) The researcher might tend to rely too heavily upon what has already occurred and not conduct much needed additional or supporting research studies.

The Survey Method. Good, Barr, and Scates (6:295) break the normative-survey into six types: (1) Survey testing, (2) questionnaire inquiries, (3) documentary frequency studies, (4) interview studies, (5) observational studies, and (6) appraisal procedures.

In this document the first of these six types was utlized. Survey testing means simply the testing of a group of children (or adults) to ascertain the prevailing condition with respects to the traits measured by the test. (6:297)

The primary purpose of such testing is not to reveal detailed facts about any particular person individually, as in the case study, but rather to indicate the prevailing conditions throughout the group. (6:298)

The development of standardized tests was not very comprehensive until the present century when Binet came forth with his revolutionizing tests for determining the intelligence quotient. The two world wars gave great impetus to the testing movement. Today literally hundreds of standardized tests measuring a wide variety of skills, traits, aptitudes, abilities, and achievements are readily available.

Monroe (13;54) quoting Wilson reports the construction of tests in arithmetic began with a problem scale by Stone in 1908 and was greatly stimulated by the Standard Research Tests, Series B, by Curtis in 1913.

In February, 1933, it was written :

> There are many schools that began the use of tests with enthusiasm and abandoned them in disillusionment. The cause of the collapse of tests in these schools is due to the disorganized piecemeal manner of using the test results, and to the lack of confidence inspired by "standardized" tests that are not only incapable of yielding comparable measures year after year, but are often inferior in other respects. (25:6)

Since this was written much research, revision, and improvement have been made on the standardized tests until today the outlook toward them has considerably changed.

In his lecture Strowig(41) pointed out that from standardized tests, one can find out more valid information than from questionnaires. Jahoda, Deutsch, and Cook (8:9-10) remind us that what people say in answer to a questionnaire or in an interview need not conincide with their thoughts and sentiments. Good and Scates (7:744) state that the

use of tests of general intelligence, aptitudes, personality, and achievement is one technique that has contributed especially to diagnosis of the student.

Barr, Davis, and Johnson (2:17) point out that,

> The semantics of the term "intelligence" is confusing because of uncertainty concerning the mental traits supposedly measured by intelligence tests. Some writers avoid the difficulty of defining this term by referring to it as "something that intelligence tests purport to measure."
>
> . . . . . .
>
> During recent years it has become increasingly evident that intelligence is not a single trait but should be regarded as a composite of abilities.

Karn and Weitz (11:256) state:

> Intelligence is measured by what are commonly called mental tests. Intelligence includes such complex functions as learning, memory, speed and flexibility of thought, attention, and seeing relationships. All these functions are related to some degree so that the term "general intelligence" is used to designate the total group.

Newland (15:80) defines intelligence as "the potential of the organism to acquire symbols, to retain those symbols, and to communicate meaningfully by means of these symbols."

Kohs (12:169) applies this definition--"Intelligence is the capacity of an individual to adapt himself to new situations."

Joelson (23:421) stresses the fact that intelligence tests, especially verbal ones, are geared in favor of abstract intellect. The fact that abstract thinkers are at an advantage in school as well as on intelligence tests gives the impression that they are more intelligent than

than concrete thinkers. This is true only if we define intelligence as the ability to think in abstract terms.

The general intelligence test attempts to measure the learner's reaction to varying types of material so that the total score resulting from composite treatment of its various sections indicates the student's potential learning ability in a variety of learning situations. (2:104)

From the results of the intelligence test, one generally derives a number commonly referred to as the intelligence quotient or IQ.

$$IQ = \frac{MA}{CA} \times 100$$

where MA is mental age as derived from the test and

CA is the chronological age of the testee.

The Terman-Merrill Revision of the Binet-Simon Intelligence Tests lists the following groups for intelligence quotients: (10:497)

140 - 169:	Very superior
120 - 139:	Superior
110 - 119:	High Average
90 - 109:	Average
80 - 89 :	Low Average
70 - 79 :	Border line defective
30 - 69 :	Mentally defective

Two criteria of any tests are it's validity and reliability. The empirical approach to validity leads to the following definition: a measuring instrument is valid to the extent that it enables one to predict from a person's score on it to his score on some other measure. (8:111)

Garrett (5:332) enumerates three procedures for determining the reliability or self-correlation of a test: (1) the test-retest (repetition) method; (2) the alternate or parallel forms method; and (3) the split-half method.

> If we know the general intelligence of a child, as measured by a standard test, can we say anything about his probable scholastic achievement as represented by grades? Problems like this and many others which involve the relations among abilities can be studied by the method of correlation.
>
> . . . . . .
>
> In theory, at least, the relationship between two abilities, as represented by test scores, may also be perfect. Suppose that a hundred students have exactly the same standing in two tests-the student who scores first in the one test scores first in the other, the student who ranks second in the first test ranks second in the other, and this one-to-one correspondence holds throughout the entire list. The relationship is perfect, since the relative position of each student is exactly the same in one test as in the other; and the coefficient of correlation (r) is 1.00.
>
> . . . . . .
>
> Relationship may also be negative; that is, a high degree of one trait may be associated with a low degree of another. When negative or inverse relationship is perfect, r = - 1.00. (5:122-24)

Super (17:650) makes the following break-down in a ranking of coefficients of correlation:

.80 and up: Very high correlation
.50 to .80: Substantial correlation
.30 to .50: Some correlation
.20 to .30: Slight correlation
.00 to .20: Practically no correlation

Limitations

In this study an attempt was made to determine the presence or absence of any existing relationship between

achievement in arithmetic and the intelligence quotient, and the degree to which this relationship exists, if any.

Some limitations on this study follow:

1. The students were tested in groups. It is possible that results would have differed if the tests had been administered individually.

2. The limited experience of the author in conducting research was undoubtedly a limiting factor.

3. The achievement tests measured achievement in arithmetic only--different correlations may exist between other subject areas and intelligence.

4. The number of students given the test may not be representative of all of the Junior High students in Atchison.

5. All of the tests were not administered by the same person. This might have had an effect on the results.

6. Test results show only conditions present at a given set of circumstances and are therefore limited in accuracy.

7. The scope did not include all achievement and intelligence levels.

Related Studies

Due to the limited time available in which the research was conducted, it is probable that not all studies related to this document were discovered. A brief of some related studies follows.

Powell. (37) In 1932 Powell made a study of relations

existing between intelligence and school subjects in grades three to six, inclusive, in the Horace Mann Training School, Pittsburg, Kansas. The purpose of the study was to determine if the students were progressing according to apparent ability.

The Otis Group Intelligence Scale and the New Stanford Achievement Tests were used. The average IQ of the group was 116. The conclusions he arrived at are as follows:

1. The classes on the basis of the national norms were accomplishing all that could be expected of them.

2. The students with the highest intelligence achieved the highest and those with the lowest intelligence achieved the lowest.

3. Achievement of each grade was satisfactory--the gains ranged from .3 to .7 of a grade whereas the expected gain was only .4 of a grade.

4. Indications from comparing accomplishment quotients of persons with IQ over 120 and those with IQ under 110 showed that both groups worked according to their ability. This indicated that the curriculum and methods were adjusted to individual differences so that each student achieved in proportion to his mental ability.

Hummer.(33) In 1934 Hummer conducted a research study on 153 tenth-year geometry pupils in the Joplin, Missouri High School. She compared intelligence and achievement in plane geometry according to the results obtained on the Otis Group Intelligence Scale and the Columbia Research Bureau Plane Geometry Test. The existing relationship was .58 ± .36

Kelly. In 1938 Kelly attempted to determine the value of ninth grade mathematics as compared with senior tests in predicting probable success in college. He used as subjects

fifty-seven graduates from Nevada, Missouri High School. He determined the coefficient of correlation between ninth grade mathematics and first year college grade point averages to be .5548.

Morris.(36) In 1945 Morris found the coefficient of correlation existing between IQ and algebra achievement was .639 ± .049. She used sixty-seven freshmen in Central High School, Commerce, Oklahoma, as the subjects in her study. Intelligence quotients were derived from the Henmon-Nelson Test of Mental Ability, form A. Algebra scores came from the Colvin-Schrammel Algebra Test, test I, form A.

Fulton. (22) In 1949 and 1950 two high schools in New York, conducted a study to determine the relationship between scholastic average and IQ. The two schools were Forest Hills High School and Tilden High School. Scholastic grades were correlated with results of the Henmon-Nelson Group Intelligence Test. The product-moment correlation was found to be .40 to .60.

Doyle. (32) In 1953 Doyle used the results of tests of 100 pupils of West Junior High School, Kansas City, Missouri, to determine the correlation between intelligence quotient and mathematics achievement. These students were given the Revised Stanford Binet Tests of Intelligence, the Progressive Arithmetic Achievement Tests (now known as the California Achievement Tests) and the Four Fundamental Combination Tests. She determined the correlations between IQ and achievement

to range from .253 to .522. The correlations between results of different achievement tests ranged from .306 to .935.

According to Ruch (16:409) there is a definite relationship between intelligence and educability. Intelligence plays a big role in determining school grades. There is a decided tendency for the correlation between marks and intelligence to be highest in the elementary school and lowest in college, with high school intermediate.

Barbe and Grilk. (20:135) How does the IQ correlate with subjects in a field other than mathematics? Barbe and Grilk found the correlation between the scores on a reading test and IQ to be .72. The reading test used was the Iowa Silent Reading Test. Intelligence quotient of the student was derived from results of the Henmon-Nelson Tests of Mental Ability.

Livingston. (35) In 1937 Livingston conducted a study involving fifty-seven high school students in determining the relationship between mental ability as determined from the Henmon-Nelson Tests of Mental Ability and achievement in history as measured by the Survey Tests of Knowledge of American History. One of the conclusions he drew forth stated, "Apparently the scholastic achievement in American History is a very good guide to mental ability, wide deviations between them being the exception rather than the rule."

Swenson. (38) This study, made in 1932, was of the

students in Commercial High School, Atlanta, Georgia, and involved correlations between IQ and commercial subjects using the results of the Otis Self-Administering Test, Form C, and tests made up by some of the instructors at the high school. He determined the following coefficients of correlation between IQ and : (1) typewriting, .26; (2) bookkeeping, .43; and (3) shorthand, .42.

METHODS OF PROCEDURE

Subjects

The students who were used as subjects for this study were all enrolled at Ingalls Junior-Senior High School, Atchison, Kansas, during the school year 1956-1957. This school houses grades seven through twelve. Total enrollment at the school is approximately one thousand students. The particular students used in this study were all enrolled in five arithmetic or mathematics classes instructed by the author.

There were thirty-eight students in the seventh grade arithmetic class. Due to transfers and absences, information relative to the study was obtained on only thirty-four of the students. These included twenty-five girls and nine boys. Although the students reportedly were picked at random from the entire seventh grade population, no explanation is available for the preponderance of girls in the class.

In the eighth grade class there were twenty-nine students. Information was available on all of them--fourteen girls and fifteen boys. These students were also picked at random from the entire eighth grade population.

The ninth grade students were selected to an extent. Part of the guidance program of the school is to give all eighth grade students the Iowa Algebra Aptitude Test, Revised Edition.(27) From the results of this test, the students are directed into one of three mathematics courses offered--algebra, general mathematics, and remedial mathematics. Past school marks and teacher recommendations are also considered in the guidance of the pupil into the proper mathematics class according to his ability. In the main, the students ranking above the fiftieth percentile of the national norms are directed into algebra. Those below the fiftieth percentile ranking, are given guidance toward entering the general mathematics and remedial mathematics courses. The taking of the course recommended according to the results of the test is not mandatory but is generally followed by most students. Only six of the ninth grade students used as subjects in this study ranked above the fiftieth percentile on the Algebra aptitude test.

There were three ninth grade classes--two of general mathematics and one class of remedial math.

Class A, remedial mathematics, contained twenty-two students, one of whom was a tenth grader and six dropped out

of school before the year was over. Information was not available for one due to absence. Therefore, the subjects in class A used for the study included five girls and nine boys.

Class B, general mathematics, included twenty-one students, one of whom dropped school and one was an eleventh grader. The remaining nineteen students were included in the study--ten girls and nine boys.

Class C, general mathematics, was composed of thirty students. Those used in this study included eight boys and sixteen girls. Two of the students of this class were tenth grade students; the others either dropped out or were transfer students for whom information was not available.

The total number of ninth grade students used as subjects for study was thirty-one girls and twenty-six boys.

Tests

Intelligence Tests. The Kuhlmann-Anderson Intelligence Test, (28) is administered to all seventh grade students a short time after their entrance to Ingalls School. The intelligence quotients (IQ) of each student is determined from the results of the tests and is then recorded in the appropriate cumulative record. Additionally, the ninth grade students were given the SRA Primary Mental Abilities Test for ages 11 to 17 (31) during the spring semester of 1957. Results of these tests were duly recorded. The

intelligence tests were administered by the guidance counselor. Results of the tests were posted in the cumulative records by his secretary. The IQ's used in this study were obtained from the cumulative records by the author.

Achievement Tests. During the third week in September, the author administered the California Arithmetic Test, Intermediate form BB, (29) to all students in his classes at Ingalls Junior-Senior High School, Atchison, Kansas. In order to determine the extent of gain in arithmetic, all students took the California Arithmetic Test, Intermediate form AA during the second week in May. As an additional check, the students were also given the SRA Arithmetic Test, Grades 6-9. (30)

The big factor behind the author's choosing of the California Arithmetic Tests was their availability. Also the coefficient of reliability between the different forms is .95. (26:4) The SRA Arithmetic Tests were given during the fourth week in May.

All arithmetic achievement tests were administered and scored by the author. The tests were administered closely following the directions in the appropriate manual. All answer sheets were hand scored and checked by the author.

Grade placement scores in tenths of a year procured from the California Test Bureau Manual (26) and the SRA Examiners Manual (30) were used in the computation of correlations. One disadvantage of the interpretation of

results on the SRA Achievement Tests is the lack of grade placements for the total score. The author averaged the grade placement norms of the three parts of the arithmetic achievement test to determine the approximate grade placement of the student on the total test. A conference (40) with the guidance counselor at the school reassured the author that the averaging of the part grade placements would give a reasonably accurate grade placement value of the whole test.

ANALYSIS OF DATA

Statistical analyses of intelligence quotients and arithmetic achievements were used in this study in an attempt to determine: (1) the degree of improvement according to ability, and (2) the effectiveness of the author's teaching.

Measures of Central Tendency

Table I shows a tabulation of the mean, median, mode, standard deviation, and standard error of the scores computed from results of IQ and achievement tests and the gain made in .86 of a school year as measured by the California Achievement grade placement scores. (26) These indicate measures of the ninth grade students used in this study, both as an entity and as individual classes, and also the seventh grade and eighth grade students as classes.

TABLE I

THE MEANS, MEDIANS, MODES, STANDARD DEVIATIONS, AND STANDARD ERRORS OF THE IQ, ACHIEVEMENT TESTS, AND .86 YEAR'S GAIN

	Mean	Median	Mode	S.D.	S.E.
All Ninth Grade Students					
IQ	89.2	89.0	88.6	10.51	1.73
Calif. Test, BB	7.33	7.10	6.64	1.165	.156
Calif. Test, AA	7.98	8.90	8.04	1.293	.171
.86 Year's Gain	.65	.60	.50	.556	.074
Class A - Ninth Grade					
IQ	80.0	79.0	77.0	5.10	1.70
Calif. Test, BB	5.95	6.0	6.10	.609	.163
Calif. Test, AA	6.45	6.25	6.30	.713	.191
.86 Year's Gain	.50	.40	.28	.300	.080
Class B - Ninth Grade					
IQ	90.7	92.0	94.6	11.84	2.960
Calif. Test, BB	7.80	7.6	7.20	1.447	.332
Calif. Test, AA	8.53	8.5	8.44	1.848	.424
.86 Year's Gain	.73	.80	.94	.463	.106
Class C - Ninth Grade					
IQ	94.0	93.5	92.5	7.87	2.272
Calif. Test, BB	7.65	7.65	7.65	1.161	.237
Calif. Test, AA	8.46	8.25	7.83	.961	.200
.86 Year's Gain	.69	.55	.27	.699	.143
Eighth Grade Students					
IQ	101.3	103.0	106.4	8.83	1.731
Calif. Test, BB	7.07	7.0	8.84	1.160	.215
Calif. Test, AA	8.59	8.7	8.92	1.587	.295
.86 Year's Gain	1.48	1.40	1.24	.761	.141
Seventh Grade Students					
IQ	104.8	104.5	103.9	13.49	2.385
Calif. Test, BB	6.34	6.25	6.07	1.174	.201
Calif. Test, AA	7.31	7.15	6.83	1.522	.261
.86 Year's Gain	.97	1.00	1.06	.790	.136

Intelligence Quotient. The mean IQ of all ninth grade students used in the study was 89.2 ± 10.51. This is significantly below the level of intelligence that would normally be found among an unselected group. The range of the IQ was 67 to 117. Only three students had IQ's above 100. Class A had the lowest mean IQ but were the most homogeneous group with a standard deviation of only slightly over 5 points. The range in IQ of the group was from 67 to 90. This was the remedial mathematics class. Class B had the widest range in IQ, from 70 to 116. Class C was slightly higher in IQ average than the other two ninth grade classes. The range was from 85 to 117. The eighth grade IQ's ranged from 85 to 118. The seventh grade class had the highest IQ average of all the classes with a mean of 104.8 and a range of from 64 to 126.

California Arithmetic Test, form BB. This was the test administered in September. As a whole the ninth grade students rated lower than the national norms--the mean grade placement being 7.33 ± 1.165. Range of the scores was 5.2 to 12.5. The range of Class A was 5.2 to 7.2. Class B ranged from 5.5 to 12.5; Class C from 5.8 to 11.0. The eighth grade was below average according to the national basis with a mean grade placement of 7.07 and a range from 4.7 to 8.8. The seventh grade ranged from 4.5 to 9.6.

California Arithmetic Test, form AA. This test was administered to the students in May. The range for this

test was 5.6 to 14.0 for all ninth grade students. Class A range was from 5.6 to 7.9: Class B ranged from 6.0 to 14.0; Class C range was 6.9 to 11.0. The eighth grade ranged from 5.8 to 11.0 with the seventh graders ranging from 4.6 to 10.3.

Gain during .86 of a school year. The total ninth grade students gained an average of .65 of a year. However, it should be noted that the standard deviation is ±.556. Many of the students in the lower IQ ranges showed little or no gain. In fact, there were some instances, apparently, of lowering of achievement level. Class A gain ranged from -.3 to 1.1; Class B from -.2 to 1.5; Class C from -.8 to 2.1 years. The student who showed the loss of .8 of a year had been detained after school just prior to taking the second test. This might partially account for the apparent lowering of grade placement. The eighth grade, last which was held from 1:00 p.m. to 1:57 p.m. showed the greatest gain of all the classes with an average gain of 1.48 and a range of .1 to 3.2 years. In the seventh grade the gain was slightly above what would be expected from an average class. The gain ranged from -.6 to 2.6 years. The student who showed the apparent loss of .6 of a grade was antagonistic toward taking the retest. This may explain the apparent lowering of arithmetic level.

Rank Correlation Coefficient and Standard Error

Table II shows the tabulation of the correlation coefficients and the standard errors of them. The correlation coefficient (r) was determined according to the following formula: (5:355)

$$r = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$

where D = difference in rank of an individual in the two series;

D^2 = the sum of the squares of all such differences;

N = the number of cases in the sample.

The standard error (σ_r) of a coefficient of correlation was determined according to the following formula: (5:197)

$$\sigma_r = \frac{1 - r^2}{\sqrt{N}}$$

An inspection of Table II will reveal that in most cases it was found that the correlation between IQ and arithmetic was significantly high. All classes except one of the ninth grade classes shows a correlation coefficient greater than .5. Class C shows a negative correlation between IQ and arithmetic achievement and gain. This class was held from 3:00 p.m. to 3:57 p.m., the last period of the school day. Fatigue then may play a significant role in the output of individuals. The most homogeneous class with respect to IQ and arithmetic achievement level, which also had the lowest

TABLE II

COEFFICIENTS OF CORRELATIONS AND STANDARD ERRORS OF THE IQ AGAINST ARITHMETIC ACHIEVEMENT TESTS, AND GAIN DURING .86 YEAR

	Correlation	Standard Error
All Ninth Grade Students		
IQ Scores versus		
SRA Arithmetic Test	.6872	.070
Calif. Test, BB	.5964	.108
Calif. Test, AA	.5719	.111
Gain	.2088	.157
Class A - Ninth Grade		
IQ Scores versus		
SRA Arithmetic Test	.5667	.181
Calif. Test, BB	.5333	.239
Calif. Test, AA	.6292	.201
Gain	.9792	.014
Class B - Ninth Grade		
IQ Scores versus		
SRA Test	.8787	.052
Calif. Test, BB	.7184	.121
Calif. Test, AA	.7125	.123
Gain	.2213	.238
Class C - Ninth Grade		
IQ Scores versus		
SRA Arithmetic Test	-.2482	.098
Calif. Test, BB	-.4405	.230
Calif. Test, AA	-.5385	.204
Gain	-.3106	.261
Eighth Grade Students		
IQ Scores versus		
SRA Arithmetic Test	.6260	.113
Calif. Test, BB	.5308	.133
Calif. Test, AA	.5735	.125
Gain	.4418	.155
Seventh Grade Students		
IQ Scores versus		
SRA Arithmetic Tests	.7901	.064
Calif. Test, BB	.8868	.037
Calif. Test, AA	.7779	.068
Gain	.5921	.115

IQ level, showed by far the highest correlation between gain and IQ. The class with the highest IQ level showed the second highest relationship between IQ and arithmetic achievement. This class was held from 11:00 a.m. to 11:57 p.m., just prior to the noon hour.

Table III shows the coefficient of correlation between the different achievement tests and the standard error of this coefficient. In the correlations between the different achievement tests, it was found that all classes showed at least a substantial correlation and in most cases the correlation between the two forms of the California Arithmetic Tests was substantially higher than that between the SRA test and either of the California tests.

In no case did the youngest student of the class receive the highest grade nor did the oldest student receive the lowest grade.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary and Conclusions

In an effort to better understand and evaluate the abilities of students in the arithmetic and mathematics classes in the future, this study was made.

As an aid in the study, all students in the writer's seventh, eighth, and ninth grade classes were given IQ tests and arithmetic achievement tests. The results of these tests were then correlated by means of the rank coefficient of

TABLE III

THE COEFFICIENTS OF CORRELATIONS AND STANDARD ERRORS BETWEEN VARIOUS ARITHMETIC ACHIEVEMENT TESTS

	Correlation	Standard Error
All Ninth Grade Students		
form BB vs form AA	.9089	.023
form BB vs SRA	.8496	.037
form AA vs SRA	.8623	.034
Class A - Ninth Grade		
form BB vs form AA	.9495	.026
form BB vs SRA	.8187	.088
form AA vs SRA	.8033	.095
Class B - Ninth grade		
form BB vs form AA	.9557	.020
form BB vs SRA	.8760	.053
form AA vs SRA	.8562	.061
Class C - Ninth Grade		
form BB vs form AA	.7496	.097
form BB vs SRA	.5787	.136
form AA vs SRA	.6415	.120
Eighth Grade Students		
form BB vs form AA	.8647	.047
form BB vs SRA	.7462	.082
form AA vs SRA	.8696	.045
Seventh Grade Students		
form BB vs form AA	.9107	.029
form BB vs SRA	.8204	.056
form AA vs SRA	.8759	.040

correlation formula.

The measures of central tendencies (mean, median, mode, standard deviation, and standard error) were computed for each test.

The ninth grade students were semi-selective according to previous tests, teacher recommendations, and past performances in arithmetic. Most of these students were of average or low average intelligence. The average gain in grade placement according to the achievement tests was less than that expected of an average group.

The seventh and eighth grade students as groups had a mean IQ of slightly above 100. The gain made by these groups was slightly to substantially more than was expected in .86 of a year. The gains being .97 and 1.48 respectively.

The correlation coefficients between scores on IQ tests and arithmetic achievement tests were substantial to very high except for one class, the last class held during the school day. All coefficients were negative between IQ and arithmetic achievement for this class--all other correlations showed a positive relationship.

The correlation between the results of the achievement tests was positive in all classes with a closer relationship existing between the two forms of the California Arithmetic Tests. This relationship, however, was not too significantly higher.

From this study it appears that the IQ score or the score made on an arithmetic test signifies to a great extent the arithmetic ability of a student. However, in isolated cases this may not be true.

The author believes that this study will be a help in understanding students' abilities and will be an aid in more wisely giving guidance to them.

Recommendations

In general, it seems that a student with a higher IQ should be expected to, and will, make a faster rate of progress and attain a higher level of achievement than a student with a lower IQ.

How much then should an instructor expect a student with an IQ of 120 to achieve and at what rate? And how much should be expected of a student with an IQ of only 80? It is evident that from the amount of knowledge available on this particular phase that several studies should be made in regard to IQ and achievement expectancy.

All students do not achieve according to their abilities. What factors other than intelligence have a limiting effect on achievement? As was pointed out earlier, outside factors have a definite effect on apparent achievement level. A breakdown of some of these factors have and will continue to provide bases for studies on underachievers and and over-achievers.

Case history studies will be an invaluable aid in helping the instructor to better understand the child under his tutelage and provide an insight into allowing for individual differences. In general, achievement scores and IQ are indicators of the child's ability but should not be the only criteria used in providing an educational plan for him.

PART II

PROPOSED PLANS FOR FURTHER RESEARCH

PART II

A PROPOSED EXPERIMENT TO EVALUATE TWO METHODS OF TEACHING GENERAL MATHEMATICS IN THE JUNIOR HIGH SCHOOL

Statement of the Problem

In this study, an attempt will be made to determine which of two instructional procedures brings out the greater apparent achievement by students in different General Mathematics classes in the ninth grade at Ingalls Junior-Senior High School, Atchison, Kansas.

Last year all students in the two general Mathematics classes instructed by the author were given a standardized achievement test in arithmetic at the beginning of the school year and another form of the same test at the end of the school year. Achievement was measured according to the results on the standardized tests. The material presented to the students in the class came largely from the textbook in use.

The students in the general mathematics classes this coming school year will be tested in the same manner as the students last year were. However, instead of relying on the information in the text, the students will be sub-divided into smaller groups which will not rely very much upon the textbook but will be instructed to obtain the latest information on a topic from sources available in the community.

The topics covered in the two classes will be the same, except possibly for minor deviations to allow for individual interests.

Purpose of the Problem

Educationalists need precise information concerning desirable and undesirable effects of the many factors that operate to affect pupil behavior. The way to secure this information is through a program of continuous experimental evaluation. (2:224)

During the 1920's and 1930's, workers in education and in educational psychology were overly optimistic in their expectations that most of the major problems of teaching and learning would be solved through the experimental method; in particular, the goals set for group experiments were too high for realization. During the latter part of the 1930's, the 1940's, and especially in the early 1950's, research workers in education, psychology, and other fields have come increasingly to recognize that a balanced program of research methodology is necessary for solving problems.(7:720-21)

As was stated earlier in this treatise, one of the writer's aims as an educator is to employ diagnostic and experimental techniques in an effort to more fully understand his abilities to educate the children in his classes.

One of the criticisms of our school systems is that the

students who graduate from high school and then go out into the world to fend for themselves are not educated as fully as they should be. It is believed that many educators will admit this criticism is a valid one.

Motivation is one of the greatest factors in determining the achievement a student will make in any given class or situation. Observation reveals that all students are not motivated to the same extent nor to a desirable degree. Through experiment the instructor can often increase this motivation in all or at least many of his students.

One of the purposes of this experiment will be to increase motivation by changing the presentation procedures--and to determine any increase or decrease in achievement level over the gain made by classes taught formerly.

From this it stands to reason that the progressive instructor must be constantly evaluating and improving his quality of material and methods of presenting it. The dormant soon becomes stagnant. Stagnancy in teaching only lessens the chances of the student to adjust successfully in the outer world of after-school life.

Only the highly dependent person can expect to exist in our modern world without a command of the basic fundamentals of arithmetic. It is only too sadly true that a large number of the junior high students are in terminal courses in mathematics. In order to make these courses more fully meet the needs of the students, the author intends to

follow through with the remainder of an experiment as will be set down in part II of this study.

Research Design

Experimental Method of Research. Experimental research may be considered as of two general types: (1) that which deals with individual situations and (2) that which uses groups of subjects. (19:215) In this study the latter type will be used.

An experimental inquiry normally brings out a situation created according to the wishes of the research investigator. (8:59) In this situation the investigator controls certain variables in order to alter change of events and to evaluate the results exhibited by these changes.

Bernard (3:13) states that two things must be considered in the experimental method:

> (a) The art of getting accurate facts by means of rigorous investigation; (b) the art of working them up by means of experimental reasoning, so as to deduce knowledge of the law of phenomena . . . experimental reasoning always deals with two facts at a time. Observations, used as starting point; experiment, used as conclusion or control . . . .

Good, Barr, and Scates (6:492-95) list three types of techniques that are generally employed in the use of groups of subjects in experimental research: (1) one-group, (2) parallel-group, and (3) rotation group.

Whitney (19:230) uses the term equivalent-groups rather than parallel-group. The terms according to definitions are

fairly synonymous. The equivalent-groups method of experimental research is used when the purpose of the experiment is to determine the superiority of one experimental factor over another and when the operation of these variables is observed in identical situations or in equivalent groups of subjects.

Monroe (13:415) points out that the success of experimental design rests upon effectiveness of the control of non-experimental factors, precision and validity of measurement, soundness of explicit and implicit assumptions, and the like. Experimental design infers consideration in advance of all types of errors to be encountered in the experiment including those which are, to an extent, controlled by proper choice of statistical method.

In an experiment, the instructor generally attempts to hold all variables as constant as possible except one. This one variable is controlled by him to a great extent. Through some means, the effects of this variable are measured.

Seven basic considerations that should be kept carefully in mind are emphasized by Whitney (19:237-40):

> 1. The problem should be carefully isolated from the confusion of the vague feeling of deficiency that precedes ordered reflection . . . .
>
> 2. The experimental factor or factors should be defined . . . .
>
> 3. The selection of the best techniques for the experimental set-up, whether one group, equivalent groups, or a combined notation of procedures or situations . . . .

4. Adequate control of all factors, all variables operating outside of the experimental factor itself....

5. The selection or making and the efficient administration of valid, objective, and reliable tests in a carefully planned measurement program. . . .

6. Report of all things done from beginning to end during the carrying through of this project. . . .

7. A possible repetition of the experiment in another situation, with other groups of subjects, on a higher level of skill in the selection of methods and techniques used.

One advantage of the experiment is that it will allow the investigator to test and develop new techniques. It can be used to help solve problems or to lead to new problems that need study and research carried out concerning them. It is also an aid in analyzing factors that may influence behavior, achievement, and attitudes.

Douglass (21:130-38) lists the following difficulties encountered in the experimental method:

1. The equating of pupils in small experimental groups cannot be done with any certainty of accuracy; therefore, where possible, hundreds rather than dozens of pupils should be used.

2. The teacher or teachers employing two or more methods to be studied should be equally skillful in the use of each.

3. Measurement of growth during the experimental period has stressed written subject matter tests of a highly factual and detailed nature to the virtual neglect of concepts, ideals, attitudes, tastes, and general powers or skills.

4. Whatever units of measurement are employed, whether reduced to standard scores or scaled units, represents an approximation which renders any further statistical treatment useful only for obtaining good estimates better than non-technical methods but are

not mathematically accurate.

5. The statistical technique necessary is often more complicated than any person, except the best trained research worker, is able to employ.

6. Interpretation of coefficients of correlations, probable errors of estimate, and other measurements of efficiency of predictions is more complicated than most research workers and many statisticians think.

7. One may not assume confidently that the method is apparently more effective for all teachers, or even for the majority of teachers or the same teachers, under conditions different from the experimental situation.

PROCEDURE

During the school year 1956-57, the students in the general mathematics classes under the instruction of the author were pre-tested and post-tested and their gain in arithmetic achievement level determined as outlined in part I of this study.

The material presented to the students came largely from the textbook Making Mathematics Work.(14) Much reliance and emphasis was placed upon the material and topics found in the text. Only a very low minimum of material in the textbook was actually supplanted or supplemented by information on the present day basis. Since the copyright date of the text is 1950, all material was at least six years behind the present day situation. Undoubtedly much of the material was one, two, or even more years older than that--allowing for time of compilation and publication.

While much of the material can still be useful and the techniques used in solving the problems may vary only slightly if at all, even one hundred years from now, it is felt that the proposed experiment will increase motivation to learn and hence increase learning.

During the forthcoming school year, full utilization will be made of community resources for up-to-date material and information. The same textbook will be used as a basis and a source for topics but the actual problems to be worked out will come from the present circumstances found in the community. These will be broadened by experiences from other areas as information is available.

Topics

The author kept a record of topics covered last school year. The same topics will be covered again this year except some few changes will be made as students desire.

Following is a list of major topics that will be discussed:

1. Earning and managing money.
2. Deductions from the pay envelopes.
3. Accounts and budgets.
4. Spending money wisely.
5. Buying by mail.
6. Carrying charges and rate of interest.
7. Household bills.

8. Checks and money orders.
9. Investing money
10. Insurance (life, health and accident, fire, automobile.)
11. Borrowing money.
12. Owning property.
13. Travel.
14. Taxes.

Some of the community resources and agencies that will be used as aids in determining present day conditions are as follows: grocers, druggists, filling station lessees, restauranteurs, mercantilists, Kansas State Employment Agency, school guidance office, school distributive occupations teachers, Federal Bureau of Internal Revenue Office, Rockwell Manufacturing Co., post office, banks, real estate agencies, newspapers, Chamber of Commerce, Consumer Report, Consumer Guide, Sales catalogues, Railway Express Agency, trucking firms, mail order houses, loan companies, utility companies, Western Union, Co-op Association, stock broker, insurance agencies, Credit Union, railroad companies, bus companies, airline agent, and County Treasurer.

There will be many other topics covered that will arise--some from outside sources--some from the textbook. The use of the drill problems in the basic fundamentals of arithmetic will not be abandoned because it was found in previous years that the students in many instances are low in the command

of fundamentals.

The students in the forthcoming classes will be tested at the beginning of the year and at the end of the year in a manner similar to that used last year. A comparison of the scores made and gain made by each group of students will help the author to determine the effectiveness of the experiment.

Subjects

The students in the first portion of the experiment have already been described. The students to be taught under the proposed plan will be selected the same way. That is they will be ninth grade students enrolled in general mathematics taught by the author. Most of them will be students who did not rank above the fiftieth percentile of the national norms on the Iowa Algebra Aptitude Test, Revised Edition, administered to them last February.

Limitations

1. The measuring of human differences is difficult.
2. The null hypothesis must be employed but the two groups to be used may not necessarily represent the normal population.
3. The author is inexperienced and this will have a limiting effect on the outcome.
4. Bias of the experimenter is a limiting factor.

5. Outside factors may affect the learning.

6. The difference in time--even though it is only one year--and the increased teaching experience of the author might alter the amount the subjects learn.

A PROPOSED PLAN FOR DETERMINING WHY STUDENTS LIKE OR DISLIKE MATHEMATICS

Statement of the Problem

In this study, two students will be considered, one of whom likes mathematics and another who dislikes mathematics.

In order to conduct this study, it will require considerable research and study to ferret out two persons who are apparently alike in many respects but who have marked differences in their attitude and liking of the subject of mathematics.

After the two subjects of the study have been determined, the research into the environmental conditions will be instituted. This research will include personal interviews with the subjects, their parents, teachers, and other persons with whom they come in contact a great deal.

The research will also go back through their cumulative records, extracurricular activities, and outside interests.

Purpose of Problem

In delving further into the research of better under-

standing the students who enter the classes of the writer, it is felt that a study of two students whose likes and dislikes toward mathematics differ sharply is necessary. The feelings toward a given subject will be a factor in determining the extent to which any student will achieve in the subject. Therefore, if one can discover why a subject is disliked, he can then attempt to eliminate, or at least to alleviate, the feeling. A case study of one who likes and of one who dislikes mathematics might bring to light some reason or reasons why these feelings are present.

Research Design

The Case Study Method. The case study method of conducting research is one of the oldest known methods, dating back prior to 4000 B. C. It was probably first introduced into this country formally in the field of law at Harvard University in 1870 and was thoroughly tried before it was used in the schools. (18:284)

Traxler (18:285) defines a case study as "a detailed study of an individual, conducted for the purpose of bringing about better adjustment of the person who is the subject of the investigation . . . ." A case history brings out the story of an individual in as complete and as objective form as possible. It does not interpret the data and it does not, in itself, bring to a focus the information on the present problems faced by the individual.

The case study is a more exhaustive study than any other type of research. It attempts to tell what problem exists, why it exists, and may predict the outcome. A case study should have a plan for follow-up. It may or may not bring out a remedial therapy that should be administered but it always implies treatment should be given. (41)

The case study covers two chronological eras--the past and the present. By delving into the past, the investigator ferrets out facts that have brought about the present circumstances and characteristics.

Good, Barr, and Scates (6:569-72) state five steps involved in making a case study.

> 1. Either by direct observation or measurement, the status of the phenomenon under investigation must be determined . . . .
>
> 2. Collection of data relative to the circumstances associated with the phenomenon under investigation . . . .
>
> 3. Checking for the presence or the absence of the antecedents thought to apply to the situation under investigation . . . .
>
> 4. If the diagnosis is to be rendered, circumstances associated with the object of study, in some manner judged necessary to improve the situation . . . .
>
> 5. The remeasurement of the phenomenon under investigation to ascertain what changes, if any, have been produced in its status by the modification made . . . .

The preparation of case studies by classroom teachers is relatively a new educational procedure and there is need for further investigation of what can be done in this field. (18:305)

In the case study it is most important that the investigator be ever alert for the detection of consistencies and inconsistencies and to be able to analyze correctly the evidence that leads to trends or behavior causes.

The case study is the most thorough-going approach to research problems and makes use of all the various tools of research. On the other hand, it is very time consuming, and often, if the subject becomes aware of the investigation he will react all the more abnormally. Too many case studies result only from overt acts of misbehavior. Often the introvertive child will remain unnoticed even though the problems confronting him are very pressing.

Related Research

In a related study, Menger (24:578-84) set down the following reasons why mathematics is a hated subject:

1. Students in the high schools have not developed the skill to cope with self-created difficulties and are therefore unable to understand part of what they hear from the teacher or read in the textbook.

2. The traditional jargon necessary to the mathematician is not always fully explained to them.

3. Sometimes questions asked by the student--simple to the mathematician but complex to the asker--receive ridicule.

4. Too often the material is not clear to the student.

Wimmler (39:37) cited the following reasons why students

take mathematics:

1. It is required for graduation.

2. They are told they will need it in the occupation they have selected to pursue.

3. They are told they will need it in the future, regardless of what their future plans may be.

Intended Plan of Procedure

Selection of Subjects. The subjects will be two students, one of whom has a very marked distaste for mathematics and the other a very marked liking of the subject. The students selected will, in other respects, be picked on a basis of as many likenesses as is possible. It is realized that the greater the number of like criteria demanded, the harder it will be to find the two subjects desired.

Some criteria that will be considered in the selection are: (1) age, (2) sex, (3) IQ, (4) status in other subjects, (5) siblings, (6) economic status, (7) achievement level in arithmetic, (7) outside interests, and (8) educational background.

In pursuit of the finding of what factors may contribute to the feelings on the subject, the author will follow many courses.

Cumulative Record. The school maintains fairly comprehensive records on all students in the system. In order for the records to perhaps yield more light on the subject, the

author will attempt to select two students who have both been in the Atchison school system for all, or at least several years, of their schooling.

Family background. A check into each of the two subject's family background will be made. Some items to be considered here are: (1) What are the occupations of the parents? (2) How many persons constitute the family? (3) What is the subject's chronological order in the family? (4) What anecdote can they relate that might tell why the liking or disliking? (5) How much encouragement is given at home? (6) How do other members of the family feel about arithmetic?

Other Instructors of the Students. They will be interviewed for possible clues as to why the students differ in their liking of arithmetic. The present and also past teachers of the students will be interviewed.

Guidance Department. Aid of this invaluable source will be utilized by having the students take diagnostic, aptitude, and interest or preference tests for information on the subjects.

Friends of the Students. Close friends of the subjects will be interviewed to see if they can throw any light on reasons why the difference in feelings of the subjects.

The Subjects. Several interviews with each subject should reveal some reasons for the difference in feelings toward arithmetic. Each of these reasons will then be pursued for further explanation.

From this study, it is felt that some factors that cause

disliking of arithmetic can be altered, if not eliminated, so that fewer students will develop distaste for arithmetic--the command of the basic fundamentals of which is almost an absolute necessity for a normal living.

Limitations

The selection of two subjects will not be adequate to diagnose why there is a difference in feelings about mathematics. However, it will give some indications and should be an aid in leading to further study.

What people say in an interview is not necessarily what they think or believe.

There is some subjectiveness in this study and therefore, it is possible that biases and misconstruing of meanings will enter in.

Research findings can never replace judgment. They only narrow the range in which judgment must operate. (7:22)

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