The effect of the summer vacation on the mathematics achievement of pupils in the Bozeman Public Schools at the fourth, fifth, and sixth grade levels

by Robert Allan Person

A thesis submitted in partial fulfillment of the requirements for the degree of DOCTOR OF EDUCATION
Montana State University

Abstract:
The purpose of this study was to determine, at the fourth, fifth, and sixth grade levels of the Bozeman Public Schools, Bozeman", Montana, any gain or loss of mathematics achievement by the pupils over the summer vacation period. The purpose also included a study of the differences in gain or loss of mathematics achievement between the sexes, the ability groups, and the sex with ability group interaction.

In this study, the 1972 Stanford Achievement Test in Mathematics was used as the test instrument. Intermediate I and II, Form A, were administered to the appropriate grade level. The subtest topics were Concepts, Computation, and Applications.

At each grade level, the pupils were classified by both the sex and the ability group. The ability groups were determined by individual performance on the pre-test. The analyses of the data was completed using the t statistic for correlated samples and a two-way analysis of variance design.

The results of the statistical analysis indicated two definite trends for the three grade levels of this study. The first trend was that a slight, but not statistically significant, gain was made by pupils in the areas of mathematics concepts and applications. The second trend was that pupils, at each grade level, had a significant loss of achievement in the area of mathematics computation. No significant differences in the summer gain or loss of mathematics achievement was indicated between the sexes for all areas but one.

This one exception was at the fifth grade level in the area of mathematics applications. Ability group differences were found to be significant at the fifth grade in concepts and at the sixth grade in computation. Statistically significant interaction was found at the fifth grade level in the area of concepts.

THE EFFECT OF THE SUMMER VACATION ON THE MATHEMATICS ACHIEVEMENT OF PUPILS IN THE BOZEMAN PUBLIC SCHOOLS AT THE FOURTH, FIFTH, AND SIXTH GRADE LEVELS

by

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A thesis submitted in partial fulfillment
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Chapter 1

INTRODUCTION

"Most educators will readily point out, and parents will agree, [that] continuous vacation for three months allows children to forget their lessons (Beckworth, 1970:19-20)." Most persons who work with elementary school children have felt a concern over the lack of retention after a summer vacation period. It is assumed that pupils grow in subject matter only while they are in school under the direction of the teacher. The expectation is that during the summer, the pupil will lose ground--"the summer slump (Soar, 1969:577)."

The summer vacation period has been of concern to teachers for a number of years. Often teachers who have had the same student in successive years noticed a seeming drop in knowledge over the summer vacation period. Teachers at all grade levels and in all subject areas frequently complain that their students do not remember important facts, skills, or information which are necessary for the students to continue their course of study. This complaint is especially prevalent in the fall of the year and is frequently directed toward the basic skills of mathematics. With this complaint in mind, teachers then proceed to spend as much as nine to twelve weeks in the fall of the year in review of the basic skills in mathematics.

Some of the questions which arise and need answers are those being investigated by this study. Do children lose in mathematics

achievement during the summer vacation? Are the children affected in the same way regardless of grade level, sex, or ability group? Are these factors of differences between grade level, sex, and ability groups to be considered in classroom and curriculum planning?

For a long while the subject has interested the writer, who has impartially summarized previous information regarding the summer gain or loss in a review of literature. It is hoped that renewed interest in the subject will result and further investigations made in the mathematics subject area, as well as other subject areas.

Statement of the Problem

The problem of this study was to determine, at the fourth, fifth, and sixth grade levels of the Bozeman Public Schools, any gain or loss of mathematics achievement by the pupils over the summer vacation period. This problem also included a study of the differences in gain or loss of mathematics achievement between the sexes, the ability groups, and the sex by ability group interaction.

Need or Purpose of the Study

The purpose of the study was to determine, statistically, any gain or loss in mathematics achievement by pupils over the summer vacation period. The need for such a study was recognized as early as 1925, when Patterson and Rensselaer stated, "The subject is one worth the study of many educators, who wish to economize the time of pupils

and in school expenses." The study is of value to the teacher in planning time allocations for specific mathematics review. The measurement instruments used in the study may also be used for diagnostic purposes by the participating schools. The data from the study will be helpful to the curriculum coordinator in planning for a mathematics curriculum.

As evidenced by the review of literature, little research has been done on the summer learning gain or learning loss in the past fifteen years. Realizing that many new teaching techniques and innovations have evolved over this time span, the generally expected learning loss may, in fact, not exist.

Questions to Be Answered

Answers to four main questions, at the fourth, fifth, and sixth grade levels, were sought in this study. They were:

1. Did pupils gain or lose in mathematics achievement over the summer vacation period?

2. Was the effect the same for males as it was for females?

3. Was the effect the same regardless of the ability group to which the pupil belonged?

4. Was the effect the same for the males and females of each ability group?

General Procedures

A proposal of the study was presented to the appropriate administrative personnel of the Bozeman Public Schools. Upon the approval of the proposal, a meeting was scheduled with the principals of each school involved in the study. The study was explained to the principals and their support and cooperation gained in gathering the necessary data. It was mutually agreed, at this meeting, that in order to gather objective data, a nationally standardized test would be used. Further, it was agreed that the mathematics teachers involved in the study would select the test instrument to be used.

A meeting was held, with the participating mathematics teachers, to determine the test instrument. At this meeting, a variety of standardized tests were presented to and reviewed by the teachers. Among the tests reviewed were the Stanford Achievement Test: Mathematics Tests; the Metropolitan Achievement Tests: Mathematics Tests; the California Achievement Tests: Mathematics; and the SRA Achievement Series: Arithmetic. After careful examination of these standardized tests, the 1972 Stanford Achievement Test in Mathematics was selected.

The testing was done in three sittings and completed during the last seven instructional days of the 1973-74 academic year and the first seven instructional days of the 1974-75 academic year. The mathematics teachers were instructed not to review any topics of mathematics prior to each testing. No special testing facilities were used; however, in

all cases the test administrator was the mathematics teacher. The test administrator followed the Test Administration Manual accompanying the Test Booklets.

Limitations and/or Delimitations

The delimitations for this study were:

1. The study was limited to grades four, five, and six of the public school system of Bozeman, Montana.

2. The study encompassed the summer vacation period for the year 1974.

3. The facilities and resources of the Montana State University Library, Bozeman, Montana, were used for a source of material in the study.

Definition of Terms

The definitions of the specified terms below were taken from the Dictionary of Education, edited by C. V. Good (1973). The three remaining definitions have been made by the researcher.

Achievement. A measure of the student's ability in terms of standardized test results; accomplishment or proficiency of performance in a given skill or body of knowledge (Good, 1973:7).

Applications. Outcomes of learning and instruction involving the use of skills, knowledge, concepts, and understandings in practical

situations (Good, 1973:34).

Computation. That phase of mathematics which emphasizes the operational skills only (Good, 1973:123)

Concepts. In reference to content, a term used by different writers to mean anything in or related to mathematics which is not considered a skill (Good, 1973:125).

Residual or difference score. The score obtained by subtracting the pre-test raw score from the post-test raw score.

Retention. The ability to retain both conceptual and computational skills in mathematics.

Review. A reexamination of material previously presented or studied (Good, 1973:502).

Summer vacation period. The time interval extending from the close of an academic year to the opening of the next academic year.

Summary

The first step in the study was to review previous studies concerning the learning gain or learning loss in the pupil's mathematics achievement over the summer vacation period. From this information, a method of approaching the problem was extracted and an abbreviated outline of general procedures formulated.

It was the researcher's intent to statistically determine any summer gain or loss of mathematics achievement by pupils and also to determine any differences in summer gain or loss between the sexes and the ability groups. This study was undertaken at the fourth, fifth, and sixth grades of the Bozeman Public Schools, Bozeman, Montana.

Chapter 2

REVIEW OF LITERATURE

In the review of literature, research studies were summarized chronologically for each of two general areas. These areas were: the studies relating to summer gain or loss of achievement, and the studies relating to boy-girl differences in achievement. Interlaced in these two areas are the results relating to ability groupings. The review included general procedures, population descriptions, and the results of these studies. Emphasis was directed toward results in the mathematics area.

Studies Related to the Summer Gain or Loss of Achievement

What is the effect on the summer vacation on children's mental ability and their retention of arithmetic and reading? Does the supernormal, the normal, or the subnormal group of children gain or lose most during the summer vacation in these respects? These were questions studied in 1925 by Patterson and Rensseler (1925:222-228).

The data from which the material for use in this study was selected was obtained in a representative city school in New York State. The number of children tested was 149. The tests used in the study were the Haggerty Intelligence Examination, Delta 2, in grades four through eight, the Thorndike-McCall Silent Reading Test in grades four through eight, the Woody-McCall Mixed Fundamentals in grades one through

six, and the Woody Scales, Multiplication Scale B, in grades seven and eight. The tests were given to the same children in September.

The Binet-Simon classification was used in classifying each grade into groups. The supernormal group was composed of those pupils with an I.Q. of 110 and above, the normal group with an I.Q. of 90 to 110, and subnormal group with an I.Q. of 90 and below.

Results from the analysis of the data showed that the greatest loss during summer vacation occurred in arithmetical achievement. Since arithmetic is largely dependent on systematic drill for mastery of fundamentals, it was recommended that all grades be given much intensive drill in the fundamentals in order to establish a firm foundation of speed and accuracy on which to build further work. Further tests should be given to ascertain the amount of loss suffered by each of the four fundamental operations so that drill may be most effectively given to remedy this loss. Further tests should be administered to determine specific causes of failure. Also, further tests should be given not only in June and September, but at frequent periods after the September testing, for diagnostic purposes and to ascertain just how quickly and when the various mental groups recover from the vacation losses.

In 1928, Elizabeth Bruene, University of California at Los Angeles, studied the "effect of the summer vacation on the achievement of pupils in the fourth, fifth, and the sixth grades (1928:309-314)." Following are some of the questions to which answers were sought. Do

children lose in achievement during the summer vacation? Is it necessary that teachers spend time on review in the fall? Do all subjects require the same amount of review? Does the long vacation affect differently the children on different levels of intelligence?

In order to study these questions, objective data was gathered with a standardized test. The Stanford Achievement Test, Form A, was given to the fourth, fifth, and sixth grades of the University Training School in May, 1927. In September of the same year, the Stanford Achievement Test, Form B, was given to the same grades. There were fifteen fourth graders, twenty-six fifth graders, and twenty-eight sixth graders in the study.

The conclusions were that for this particular group, the summer vacation had a decided detrimental effect on arithmetic computation, the total loss being six school months. In arithmetic reasoning, the loss was negligible, only six-tenths of a school month. The summer vacation was not detrimental to reading ability. The vacation brought forth a loss in spelling, in language usage, and in history and literature. Slight gains appeared in nature study and science. In reading more of the bright children gained or remained the same, while in arithmetic, both computation and reasoning, more of the average children fall into that class.

Recommendations were that for subjects which showed a decided loss, principally arithmetic computation, some review would not be

amiss. Since most children lose in arithmetic and spelling, and many of those in the lower I.Q. group in reading, it seemed advisable that those below the norm or just above the borderline in the spring, spend at least part of their vacation time in school or doing school work if they hoped to keep up with their grade in the fall.

This study raised some interesting questions. For example: Did those who gained go to summer school? What activities, if any, did these children engage in during the summer which called for exercise of reading and arithmetic abilities? If any, to what extent?

During the same year, M. J. Nelson (1928:305-308), Iowa State Teachers College, conducted a study pertaining to the "amount of time required for pupils to regain the knowledge and skills lost during the summer vacation period." The grade levels studied were the third, fifth, and the seventh. Again, standardized tests were used to gather the objective data.

The results of this study indicated that grade seven had regained the spring level of achievement, in speed in solving arithmetic problems involving only the fundamental processes, at the end of four weeks following the opening of school in the fall. In the number of problems solved correctly, they had again reached the spring average six weeks after the opening of school, and in spelling within two weeks. Grade five had regained the spring level of achievement sometime after the end of the six weeks' period and prior to the winter tests, in

arithmetic attempts and rights and also in spelling rights. Grade three had regained the spring level of achievement in spelling by the end of the six weeks following the opening of school in the fall.

From the analysis of the results of this investigation, it was recommended that a review of the fundamental processes in arithmetic during the first month of each school year would yield large returns, in restoring the habits that have deteriorated through disuse. Where the deterioration was slight, such review appeared to increase the achievement far above the level attained during the previous year.

Marie Schrepel and H. R. Laslett (1936:299-303) of Oregon State College, Corvallis, Oregon, studied the loss of knowledge by junior high school pupils over the summer vacation. The purpose of the study was that of measuring the amount of forgetting of factual material by junior high school pupils over a summer vacation lasting three months and two weeks.

In this study, a preliminary experiment involving fifty-one pupils in arithmetic fundamentals and seventy-four in arithmetic reasoning was carried out in 1933. The Los Angeles Diagnostic Tests in Arithmetic were used. The tests were given twice to the same pupils--once late in April and again during the first week of school in September. As these pupils were in the eighth grade, they were receiving instruction in arithmetic at the time, but no special effort was made between the April test and the close of school to stimulate

these pupils in the retention of number facts and relations. No mention was made of a second test to be given in the autumn until the time at which the test was to be administered. No summer-school training was open to any of the pupils involved in either of the experiments in this study.

A second experiment involving the pupils in the eighth and ninth grades of a junior high school and employing the New Stanford Achievement Test was carried out in 1934 in much the same way as the earlier experiment had been except that the spring test was given during the last week in May instead of in April. Form W of the Stanford Achievement Test was used in the spring and Form V in the autumn. The number of students involved was 121 who completed both forms of this test. Of these, seventy-two were in the eighth grade and forty-nine in the ninth grade.

A summary of results revealed that pupils of the junior high school, as determined by the 172 pupils of this study, do not show any serious losses of knowledge of subject matter over a summer vacation of fourteen weeks, with the possible exception of knowledge of arithmetic computation. In fourteen out of the twenty-two subtests, these pupils showed actual gains in factual knowledge over the summer vacation. These were small mean gains, probably due to the maturation of the nervous systems of the pupils and to their free reading. These pupils returned to school with greater reading ability than they had when they

left the school in the spring. The pupils of greater mental age, as a group, lost less or gained more knowledge over the summer than did the pupils of lesser mental age. As a group, they also made decidedly higher scores on the tests than the pupils of lower mental ages. This raised once more the question of the value of speed in education versus maturation of the nervous system in pupil grade-placement. It was suggested that the strenuous reviews in which some teachers indulge each fall to overcome the loss of knowledge that the pupils are supposed to have sustained over the summer do not seem to be warranted by the amount of forgetting shown by this experiment. Moreover, the author studied these severe reviews are psychologically and pedagogically questionable, if not clearly wrong.

Ruth Cathryn Cook (1942:214-219), State Teachers College, Mankato, Minnesota, undertook a study to determine the vacation retention of fundamentals by primary grade pupils. Cook, in cooperation with Helen Naber, first-grade supervisor at Mankato State Teachers College, carried out an experiment which had previously been used by Cook in an attempt to increase summer retention. Several weeks before school was dismissed, the teachers and the children in grades one and two prepared work envelopes designed to occupy from fifteen to twenty minutes a day, five days a week for the duration of the three summer months. It was recommended to the parents that the children be reminded of the work to be done each morning.

During the last two weeks of school, the Gates Primary Reading Tests were given to the first grade children. Both the Gates tests and the Primary Reading Test of the Metropolitan Achievement Tests were given to the second grade. The second grade children were also tested on the one hundred addition facts from the "Test and Practice Pad of Second Grade Arithmetic."

In September all the children were retested by Cook. The Gates Primary Reading tests were used for the group coming from grade one into grade two. Those children who had been sent to grade three were given the same test and in addition the Primary Reading Test of the Metropolitan Achievement Tests.

Based on the summer work, the children seemed to fall naturally into three groups. There were those who forgot their work entirely or dropped it after two or three weeks, those who worked up to or just after the Fourth of July, and those who worked all, or nearly all, summer.

In general, the pupils who practiced all summer retained their reading skills or made some gain. On the whole, the less the amount of practice, the greater the loss of ability. However, although the group tested was very small, the author felt that practice during the summer probably helped retention. Children with intelligence quotients above 100 were more faithful to their work and with but one exception gained over the summer. Children with I.Q.'s below 100 had a tendency to

retain their spring scores when working for more than seven weeks during the summer.

K. M. Parsley and M. Powell (1962:287-342) conducted a study which investigated academic gain or loss and summer gain or loss in achievement as measured by achievement test scores in six areas of subject matter material. Attention was directed at sex trends and grade level trends.

The subject matter areas under consideration were those measured by a nationally standardized test, the California Achievement Test Battery. These areas were Reading, Vocabulary, Reading Comprehension, Arithmetic Reasoning, Arithmetic Fundamentals, Mechanics of English, and Spelling.

The sample used in this study included 1,080 boys and girls attending the Willoughby-Eastlake public schools in the second through the seventh grades. Ninety boys and ninety girls were randomly selected from those students with I.Q.'s between 90 and 110 at each of the grade levels. The I.Q.'s were determined by the California Test of Mental Maturity. This 90 to 100 I.Q. range was used in order to study the academic and summer gain or loss characteristics of the "average" child.

The type of test used permitted inter-grade comparisons. Different forms of the test batteries were administered to each student in the fall following the summer vacation period. Results from the

statistical analysis of the data were available for each of the six subject areas studied; however, only the results pertaining to the arithmetic area will be reviewed here and only those results pertaining to the summer gain or loss of achievement.

Girls do not appear to gain more than boys in Reading, but do not tend to gain more in Spelling and Mechanics of English. The general point of view that girls excel in language is supported, so long as Reading is not considered a language area. However, its exclusion does not seem appropriate, especially since Reading Vocabulary deals so directly with words and their meanings. Insofar as summer gains or losses are concerned, the conclusions drawn in this study neither support nor refute the theory.

Parsley previously generalized that boys excel in Arithmetic Reasoning and that girls excel in Arithmetic Fundamentals. The conclusions drawn in this study which are related to summer change do not support this theory. Boys gained significantly less than girls in Arithmetic Reasoning at the second and third grade levels and tended to gain less than girls at the fourth, fifth, and sixth grade levels. There were no sex differences reported in Arithmetic Fundamentals.

Gains in Arithmetic Reasoning seem more stable than gains in Arithmetic Fundamentals. There appear to be ways in which summer gains and losses in Reading Comprehension, Arithmetic Reasoning, and Mechanics of English follow a common pattern. The authors speculated that these

subtests may tap similar cognitive processes since they investigate apparently independent subject matter areas. [However, Parsley and Powell felt further study was needed in order to draw conclusions about the interrelationship.]

Lloyd F. Scott (1967:145-151) conducted a study with the purpose being to compare the "summer loss in modern and traditional elementary school mathematics programs." The study was prompted by manifest impressions of the teachers of the University of California Laboratory School. Several of the teachers noted that "It seems to be more difficult to bring children back to their spring achievement level after the summer vacation." The impression was that the common "summer loss" was greater for the modern program than for the traditional program.

In order to determine the reliability of the subjective impression, a series of tests were constructed during the spring of 1964. The tests were designed to measure concepts and skills included in both modern and traditional programs for grades one, two, and three. The tests were administered in June of 1964 to sixteen classes of children, eight in the Washington Laboratory School and eight in the Whittier Laboratory School. The testing was repeated for the same children during the first week of school in September 1964. Because the initial results included one group whose mean score was actually higher for the fall than for the spring test and because the superior

retention of the material by the traditional group was found with the smaller samples of children, it was decided to repeat the study with some modification.

It was found that contrary to the expressed opinion of teachers there were no apparent systematic difference between modern and traditional programs on children's retention of mathematics achievement over the summer months. There were no obvious retention patterns favoring either the modern or the traditional programs. Most children suffer some summer loss in arithmetic achievement regardless of the program they are studying.

Robert S. and Ruth M. Soar (1969:577-587) conducted a study pertaining to "pupil subject matter growth during summer vacation." Three questions were studied. How does summer growth compare with school year growth? What is the relation between teacher-pupil behavior in the classroom and the subject matter growth of those pupils the following summer? Are there stable individual pupil differences in the tendency to show growth during the school year in contrast to growth during the summer?

In an attempt to answer these questions, data was collected from all of the fifth grade classrooms in a metropolitan area in central South Carolina. Although these classrooms were not necessarily representative, the schools did span a broad range of socioeconomic levels. All teachers and pupils were Caucasian. In all, complete data

for the fifth and sixth grade years were obtained from 189 pupils.

The pupils' measures used in the study consisted of the vocabulary, reading, and arithmetic subtests of the Iowa Tests of Basic Skills. Administration of the tests the fall and spring of the sixth grade were carried out by project field staff; the fall sixth grade tests were administered by the classroom teachers. Teacher-pupil behavior in the classroom was observed using Flanders Interaction Analysis and items from several revisions of the Observation Schedule and Record, the Hostility-Affection Schedule, and a number of original items.

Only results relating to "summer growth" were reviewed. In general, the relative growth for Vocabulary was approximately eight months for the first year, four months for the intervening summer, and seven and one-half months for the second year. For reading, the same periods showed approximately six and one-half, three and one-half, and nearly seven months; for arithmetic concepts, six and one-half, three, and seven months; and for problems, approximately seven, five, and eight.

In June of 1973, Woodrow Mousley (1973:705) reported on testing the "summer learning loss" argument. In cooperation with Jim Abbot, principal of Los Arboles Elementary School in California, three third-grade classes were given the Stanford Reading Achievement Test just before the close of school in June, 1972. The same children were again

tested with a different form of the same test two days after school commenced in September, 1972. In both the June and September testing, the same directions for administering the tests were carefully followed. Each time the tests were given to all three groups by the same examiner. In the pre- and post-summer testing, students were told they would receive a chocolate candy bar if they did their best.

The children in this study did not suffer a loss in reading ability despite the lapse of eighty-five vacation days. In fact, they made a slight gain. One can argue, of course, that during three months of vacation the children's normal maturation accounted for the maintained reading ability, or that they practiced reading for pleasure but did not practice other basic skills, such as arithmetic. What is clear from the evidence of this study is that children's reading ability was not adversely affected by a three-month summer vacation.

Since considerable time is spent developing division skills during the fourth grade, and since fifth-grade teachers build on the skills developed in the previous grades, a study was undertaken to ascertain the extent to which specific kinds of division skills are retained from the fourth to the fifth grade. More pragmatically, the study helps answer the question: Were the fourth graders developing the skills and then forgetting them over the summer, or were the skills never well developed? This study was reported completed in 1973(65-71) by Ray Kurtz, Kansas State University.

The design of the study provided for the testing of all fourth graders in a small city school system and the retesting of those same children at the beginning of the fifth grade. Using scope and sequence information, a sixteen-item test was devised to assess various computational skills in division at the fourth grade level. Scores from 343 students were included in the analysis.

The results of the study provide evidence of significant summer loss in the ability of fifth grade students to work division problems. After comparing the summer loss for students in the various quartiles, a pattern emerged suggesting that students in the upper quartile registered considerably more summer loss than students in the lower quartile. This information supported the position that even the best fourth grade students needed considerable review in the fifth grade. The fact that fourth grade students who scored in the lowest quartile were able to work little more than 25 per cent of the problems correctly in the fifth grade verified the need for developmental instruction in division processes. Kurtz suggested that a short review might be sufficient for upper quartile students, but it was inadequate for those in the lower quartile.

This study presented sufficient evidence to support the conclusion that mastery of fourth-grade division was not satisfactorily attained by over one-half of the fourth graders. When this mastery level was further reduced by the attrition caused by summer vacation,

it was evident that a fifth-grade teacher should be prepared for considerable variation in division skills in each new class.

Studies Related to Sex Differences in Achievement

In 1962 Robert D. Muscio reported on a study of the "factors related to quantitative understanding in the sixth grade (1962:258-262)." The investigation was conducted with the primary purpose of determining the relationships between sixth-grade pupils' quantitative understanding and certain mental abilities, achievements, and attitudes. The sample population consisted of 413 subjects (206 boys and 207 girls) enrolled in 14 sixth-grade classes in three schools within the Richmond School District (Richmond, California). The following tests were administered to the students over a period of three weeks in the fall of 1957:

> Functional Evaluation in Mathematics,
> Test 1. Quantitative Understanding (the criterion test);
> Stanford Intermediate Arithmetic Test:
> Arithmetic Computation and Arithmetic Reasoning;
> Stanford Intermediate Reading Test:
> Paragraph Meaning and Word Meaning;
> Gates Basic Reading Tests, Test C,
> Reading to Understand Precise Directions;
> Gates Basic Reading Tests, Test D,
> Reading to Note Details;
> California Vocabulary Tests, Mathematics;
> Arithmetic Attitude Scale;
> California Test of Mental Maturity, Short Form.

Some of the conclusions drawn from this study were as follows. There was a significant sex difference in favor of boys on the measure

of quantitative understanding utilized. Neither general intelligence nor computational skill accounted for this difference. Muscio felt it important, therefore, to ensure that the instructional program in arithmetic consider such sex differences as are thought to exist in the areas of interests, attitudes, personality, etc. that may affect the direction and quality of learning.

Achievement on the measure of quantitative understanding was closely related to achievements on measures of arithmetic computation, arithmetic reasoning, and mathematical vocabulary. Such relationships were attributable, in part, to the considerable overlap of skills and abilities to be found within these areas of learning.

Achievement on the measure of quantitative understanding was closely related to achievement on measures of general reading ability. The relationship to more specific reading abilities was somewhat lower, although positive.

Achievement on the measure of quantitative understanding was closely related to intellectual capacity, with much the same general relationship existing between each mental factor and quantitative understanding as existed between total mental score and such understanding. Further, mental language factors were more closely related to quantitative understanding than were nonlanguage factors. It appeared evident that the verbal facility required for much quantitative thinking, as indicated by this study, must be considered when

determining the content of the arithmetic program. In addition, the close relationship between language and thinking must also be recognized when developing appropriate learning experiences for children, according to the author.

Attitudes toward arithmetic did not provide a reliable index of the level of quantitative understanding. It seemed clear that content must be developed on the basis of meaning and significance to the learner rather than on the basis of palatability.

High achievers on the measure of quantitative understanding were likely to be somewhat younger than low achievers of the same grade level. This pattern had generally been found to exist with respect to general school achievement. Substantial relationships existed among the several arithmetic achievements measured and general intelligence. However, the considerable variability shown by individual achievement profiles was evidence of the apparent lack of any "general" arithmetic ability.

Marked variability was evident even when children were grouped on the basis of achievement on any one measure, in this case scores on the test of quantitative understanding. Wide differences might be expected between the extremes of any school group, while any individual may well exhibit great range and diversity in the several school achievements.

Were there really sex differences in achievement? Kenneth M.

Parsley, Jr. (1963:210-212) investigated this question and reported his findings in 1963. For this study, the California Reading Achievement Test, the California Arithmetic Test, and the California Test of Mental Maturity were administered to all of the children in grades two through eight in an urban-suburban school district in Ohio. Only those children who completed all three tests were included in the study, and the final sample consisted of 2,651 boys and 2,369 girls.

Five scores were recorded for each child: the total I.Q., the Reading Vocabulary Grade Placement, the Reading Comprehension Grade Placement, the Arithmetic Reasoning Grade Placement, and the Arithmetic Fundamentals Grade Placement. After an initial analysis was done involving the total group, the population was then divided into five I.Q. groups: 75-94, 95-104, 105-114, 115-124, and 125 and up. These divisions were made by grade and sex.

The results were found to be quite contradictory to results of most earlier studies in which substantial sex differences in achievement were found to exist. The results were as follows:

The first analysis was done between the sexes in each grade for the total group (I.Q. range of 75-160); for each of the four achievement areas there were no significant differences between the sexes within grade level for any of the achievement areas studied. The results of the analysis based on the five I.Q. groups and the differences between the sexes failed to approach significance and were, in fact, very small.

(Are boys better than girls in arithmetic?) Wozencraft (1963: 486-490) also challenged the assumption that boys were better than girls in arithmetic. Wozencraft found that when studying groups of boys and girls in the third and sixth grades of the Cleveland, Ohio schools that the girls in both of these grades were in most instances better in arithmetic than the boys. The degree of difference depended upon the intelligence of the children. This study pointed up the importance of being specific about grades and levels of intelligence when making comparisons.

Differences between sexes were fewer in number and of less significance in the sixth grade than in the third grade and in high and low intelligence levels than in the average or total groups. Boys were not superior to girls in arithmetic at any intelligence level or in either grade.

The study was based upon 564 cases of the total grade three population of 5,708 pupils and 603 cases of the total grade six population of 5,059 pupils in 1955. Cases were selected by a stratified random sampling technique from the 121 schools in the city. The stratified sampling method insured the inclusion of individuals from all sections of the city of Cleveland proportionately.

Both grades were divided according to intelligence into three groups: low, average, and high. Low included those with intelligence quotients from 55 to 80; the average groups ranged from 90 to 109, and

the high 110 and over.

Comparisons were made between girls and boys on the scores obtained on the Stanford Achievement Tests given to all Cleveland children in May, 1955.

In 1964, Oscar T. Jarvis (1964:657-659) reported on a study of "boy-girl differences in elementary school arithmetic." This study considered the important question of whether or not boys and girls of similar chronological age and grade placement within the elementary school were capable of doing the same level work since their maturational patterns of development differed markedly.

This significant question prompted an investigation into the educational status of 347 girls and 366 boys in arithmetic at the sixth grade level. The students were tested to ascertain the status of their achievement in the areas of arithmetic reasoning and fundamentals. They were also given an intelligence test. The testing instruments used to gather the necessary data were the California Short Form Test of Mental Maturity and the California Achievement Test Battery, Form W. The tests were administered in April.

The pertinent findings were that the bright boys of the study, i.e., those possessing I.Q.'s of 115 or more, were found to be superior to their peer group of girl students in both arithmetic reasoning and fundamentals. And all four classifications of male pupils, i.e., the bright, average, dull, and the total group, excelled the female students

in their ability to perform arithmetic reasoning functions. Also, all classifications of girls were superior to boys in their ability to execute the arithmetic fundamental operations with the exception of the bright group where the male pupils were found to excel.

In 1964(268-269), Kenneth M. Parsley, Jr. reported on a "further investigation of sex differences in achievement of under-, average-, above-achieving students within five I.Q. groups in grades four through eight. This is a follow-up of a study previously reviewed entitled "Are there really sex differences in achievement."

This study included the entire population of the fourth through eighth grades (a total of 3,551 pupils) of a small urban school district with a generally middle socioeconomic class population. All students were administered the appropriate levels of the California Test of Mental Maturity and the California Achievement Test Battery. On the basis of the results of the California Test of Mental Maturity, the population was divided, by sex, into five I.Q. groups: 75-94, 95-104, 105-114, 115-124, and 125 and up.

Generally, the findings related to reading achievement seemed to be in agreement with earlier studies, indicating that girls excel in this area. The results on arithmetic achievement were not as clear. The general consensus had been that the boys excel in arithmetic achievement, but this study only partially confirmed this point of view. Boys do excel in Arithmetic Reasoning, but not in Arithmetic Fundamentals.

Parsley felt that this was a most important differentiation for teachers and other school personnel to be aware of.

A research study was undertaken by Esther Unkel (1966:662-670) to determine any statistical interaction of each of the two factors of socioeconomic status and sex with the discrepancy scores in elementary school mathematics. The difference between the anticipated achievement score and the actual achievement score was referred to as the discrepancy score.

Pupils from Grade 1 through Grade 9 were drawn from the public schools of Syracuse, New York and Worcester, Massachusetts. Seventeen boys and seventeen girls were chosen at random from each grade tested in each of three socioeconomic groups. This was a sample of 918 children chosen at random from a total of 1,645 children tested.

Schools in Syracuse and Worcester, representative of the low, middle, and high socioeconomic status for the given city, were selected by the school administrators. A further check of socioeconomic status was made by determining the occupation and years of formal education of the main breadwinner for each family through the use of cumulative records in the school office and a simple questionnaire filled out by the pupils from grade four through grade nine.

Each pupil in grade one through grade nine was given two tests: a mental maturity test and an arithmetic achievement test. Form W of the California Arithmetic Achievement Test, 1963 norms, 1957 edition was

used. The mental maturity test used was the California Short Form Test of Mental Maturity, 1963 revision, appropriate to the pupil's grade classification in school.

Some of the results from this study were that:

1. Socioeconomic status had a significant effect on achievement in arithmetic even when based on the difference between a pupil's actual achievement score in arithmetic and his presumed potential (chronological age, grade placement, and his score on a test of mental age.)
2. A statistically significant difference was found in the discrepancy scores between boys and girls in arithmetic fundamentals only. The girls had higher discrepancy scores.
3. Children of all socioeconomic groups, both boys and girls, had a total of more negative discrepancy scores in grade one and grade two than at any period in the span of grades one through nine. There was a sharp increase in the positive discrepancy scores in grade three, with the exception of pupils in the low socioeconomic group, who require an additional year before their discrepancy scores increased in the positive direction.
4. There were some evidence that pupils in the low socioeconomic groups required a greater length of time to increase their positive discrepancy scores than pupils in the middle and high groups.
5. There was more fluctuation of the discrepancy scores for all children in arithmetic fundamentals than in arithmetic reasoning or arithmetic totals.

A study of certain psychological and sociological characteristics as related to arithmetic achievement was reported by Cleveland and Bosworth (1967:383-387). The purpose of this study was to discover whether there were statistically significant differences between the top-quarter arithmetic achievers and the bottom-quarter arithmetic achievers at sixth-grade level in certain psychological and sociological characteristics. These characteristics included the personality dimensions found on the California Test of Personality (1953 revision),

Elementary Form AA--grades four through eight, the Dutton Arithmetic Attitude Scale (adapted), sex, and two socioeconomic levels.

The characteristics were studied at three I.Q. levels, in relation to three aspects of arithmetic learning, i.e., skills, concepts, and problem solving. The study attempted to make a special contribution by investigating these three relatively independent aspects of mathematical competence separately.

This study appeared to corroborate previous research which had indicated that there was a positive correlation between arithmetic achievement and a psychologically healthy personality. The higher achievers of both sexes and from both socioeconomic levels of school environment attained higher scores in the areas of Personal Adjustment, Social Adjustment, and Total Adjustment.

Differences were more pronounced within the "average" range of intelligence (I.Q. 90-110) than within either the higher or the lower ranges.

The range of achievement was generally higher in the higher socioeconomic level of school than in the lower one, even within equivalent I.Q. groups. Also, socioeconomic level was positively related to such factors as social standards, social skills, school relations, and self-reliance, on which achieving children from the higher-level schools attained higher ratings than their counterparts in lower-level schools.

Although scores on the Dutton Arithmetic Attitude Scale showed some instances of positive correlation between attitude and achievement, results were not general enough to indicate that the test, at least in this form, could become a useful predictor.

The study showed few differences between the sexes in arithmetic achievement or sex differences in relationship to personality factors.

The purpose of a study by S. Singhal and P. Crago (1971:417-419) was to examine the effects of six differences in the school gains of migrant children. Included in the study were 777 boys and 775 girls from migrant workers' families in New York State for whom pre-test and post-test data were complete. The Wide Range Achievement Test (1965) was selected as a measure of migrant children's achievement in reading and arithmetic.

Results showed that significant differences in reading achievement of boys and girls at grade four were in favor of the boys. In arithmetic achievement, differences were significant at the grade levels three, four, and nine in favor of boys. In the total group, boys and girls did not differ in reading or arithmetic gains. No indications were found of migrant children's school gains being affected adversely either by the teacher's discriminatory behavior in favor of girls or by the family structure.

How well do children today understand mathematical terms as compared with children of several decades ago? Do children today

understand the terms used in modern mathematics textbooks better than the terms taught years ago as well as the children who were then studying these terms? Do boys and girls differ in achievement in vocabulary? Olander and Echmer (1971:361-367) completed a study designed to answer these questions.

Since no good test of contemporary mathematics vocabulary for elementary schools was available, a test of one hundred items (Contemporary Mathematical Vocabulary Test) was constructed. Modern-day pupils in grades four, five, and six were given this test. Their performance on this contemporary test was compared with their performance on the Buswell-John Vocabulary of Arithmetic Test. The performance of today's children on the Buswell-John test was also compared with the performance of the pupils who were given the test in 1930.

A study by Buswell and John provided a test of mathematical terms in use in elementary schools three or four decades ago; the study also provided data on how well school children at the time performed on the test.

The Buswell-John Vocabulary of Arithmetic Test and the Contemporary Mathematical Vocabulary Test were administered to twelve hundred children, four hundred in each of the grades four, five, and six. The children who took the tests attended schools in six school districts randomly selected from ninety-four districts in a Tri-State Area School Study Council in western Pennsylvania. The classes that took part in

the study were also randomly selected.

On the Buswell-John Vocabulary or Arithmetic Test, the 1968 pupils outscored the 1930 group on seventy-four of the one hundred items at the fourth-grade level, on fifty-nine terms at the fifth-grade level, but on only forty-eight terms at the sixth-grade level. That is, in sixth grade the 1930 group was slightly better than the 1968 group.

How well did boys achieve compared to girls? On the Contemporary Mathematical Vocabulary Test, the girls outscored the boys at all grade levels. This was also true for the Buswell-John Test.

The 1968 pupils took two tests in addition to the Buswell-John Vocabulary of Arithmetic Test and the Contemporary Mathematical Vocabulary Test. These pupils were administered the subtests in arithmetic and reading of the Stanford Achievement Test, Intermediate (1964), and also the Kuhlmann-Anderson Intelligence Tests, Seventh Edition (1963). On the Stanford subtests, girls outscored boys at all grade levels in arithmetic computation, but in arithmetic concepts and applications girls outscored boys only in fourth grade.

In all three grades in all schools in the study, girls as well as boys scored significantly lower in arithmetic computational skills than in the other areas of mathematics that were tested.

The National Longitudinal Study of Mathematical Ability (NLSMA) is one of the most extensive studies of mathematics achievement that has been done. Elizabeth Fennema (1974:132-134) summarized this study

in an article for the Journal of Research in Mathematics Education. The article was entitled "Mathematics Learning and the Sexes: A Review."

Data concerning one group (the X-population) were collected for five years as the students progressed from grade four through grade eight (Carry and Weaver, 1969; Carry, 1970) and data from another group (the Y-population) were collected for four years as the subjects progressed from grade seven through grade ten (McLeod and Kilpatrick, 1969; Kilpatrick and McLeod, 1971). Although the main variable studied was the impact of various textbook series on learning, sex was also used as a basis for analysis. The sex data analyses were reported in the appendices of the various volumes and it appears that the differences found between the sexes were large enough to be educationally significant.

Evaluation instruments used to assess learning at all grade levels were classified by categories of mathematical content (number systems, geometry, and algebra) and by cognitive complexity of the task (computation, comprehension, application, and analysis). Data collected from these instruments were first analyzed for a sex X textbook interaction and if no significant interaction was found, the data were analyzed separately by sex and also for sex differences.

In both populations, girls performed slightly better than did boys in the least complex skill (computation). In twenty-one out of

fifty tests of computation, girls surpassed boys and boys surpassed girls eleven times. However, the highest per cent of significant differences were found in the X-population at grades four through six. With the older subjects of the Y-population, fewer significant differences in computation were found. In the seventy-seven tests of more complex cognitive skills (comprehension, application, and analysis), five tests had results that favored girls, while fifty-four tests showed significant differences in favor of boys.

Fennema's conclusion of this study was that the boys of these populations learned the mathematics measured by these tests better than did the girls of these populations. The girls appeared to have done slightly better at younger ages in a low-level cognitive skill; but by the time puberty was well established (ninth and tenth grades), boys were outperforming girls at all levels of cognitive complexity.

Summary

Concern over the "summer learning loss" has extended from the early 1920's to the present. Often accepted as an educational consequence of the summer vacation period, it has not always been substantiated with actual statistical data.

The review of literature was presented for two major areas. The first area specifically focused on studies relating to the summer learning loss, while the second focused on studies related to the boy-girl differences in achievement. Included in the review of these two

areas was the information on a third area of ability groupings. General procedures, population descriptions, and the results were presented for each of the studies in the review.

The majority of the research on the summer learning loss did indicate some learning loss, however small. In some of the studies, the loss was statistically significant. For the studies of the boy-girl differences, no general conclusions were made. The review emphasizes the importance of being specific about grades and levels of intelligence when making comparisons of boy-girl differences in achievement.