THE EFFECTS OF AN OBJECTIVE-CENTERED, SEQUENTIAL PROGRAM OF PHYSICAL EDUCATION ON THE ACADEMIC ACHIEVEMENT AND INTELLIGENCE OF ELEMENTARY SCHOOL-AGED CHILDREN

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ABSTRACT

THE EFFECTS OF AN OBJECTIVE-CENTERED, SEQUENTIAL PROGRAM OF PHYSICAL EDUCATION ON THE ACADEMIC ACHIEVEMENT AND INTELLIGENCE OF ELEMENTARY SCHOOL-AGED CHILDREN

By

Richard Edwin Mosher

The purpose of this study was to investigate the effects of a one-year, objective-centered, sequential program of physical education upon the academic achievement and mental ability of male and female children enrolled in kindergarten through grade five.

Two hypotheses were proposed: (1) a one-year, objective-centered, sequential program of physical education will not significantly affect the academic achievement and mental ability of elementary school children, at any level, kindergarten through grade five; (2) a one-year, objective-centered, sequential program of physical education will not affect males and females in a significantly different manner, at any level, kindergarten through grade five, with respect to academic achievement and mental ability.

Two schools, one experimental and one control, were selected from the Waverly School District. All students in kindergarten through grade five, at both schools, were tested (N = 607).*

*Total N = 597 after deletions due to insufficient data.

Three tests, the Stanford Early School Achievement Test, the Stanford Achievement Test and the Otis-Lennon Mental Ability Test, formed the test battery administered to the children in grades K-5. Different forms of the same test were administered for pre-test and post-test data collection.

The children in grades K-5 attending the experimental school received a one-year physical education program based on the curriculum developed for the Battle Creek Public School System. The program was a research-based, objective-centered, sequential program of physical education, covering a wide range of skills and activities. Stress was placed on the total development of the child and particular activities were presented to enhance social, emotional, cognitive and physical functioning.

A series of multivariate covariance analyses were employed to determine if significant differences existed between the control and experimental groups with respect to the dependent variables, the post-test academic achievement and mental ability scores. Pre-test scores were used as the independent variables (co-variates) in the analyses.

The results of the present study indicate that the one-year, objective-centered, sequential program of physical education did not facilitate the learning of academic concepts of children in grades kindergarten through five. Although isolated effects were noted throughout the grade levels, no consistent trends were evident. Further analysis indicates that the one-year, objective-centered, sequential program of physical education had no differential effect on the males and females in the experimental group. Although isolated sex differences were noted, no consistent trends appeared throughout the study.

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By

Richard Edwin Mosher

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Dedication

To my wife Jean for her unfailing support
and encouragement, without which the
task would have been impossible

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CHAPTER I

INTRODUCTION

Introduction

The belief that the mind and body are closely interrelated is certainly not a new concept. The Gestaltist philosophy that the individual functions as a "whole" has been accepted by many psychologists and educators and is expressed aptly by Hall and Lindsey (1957) in the following quotation:

> "The organism always behaves as a unified whole and not as a series of differential parts. Mind and body are not separate entities, nor does the mind consist of independent faculties or elements and the body of independent organs and processes." (p. 297)

Olson's "Organismic Age" (1949), through which the author professes a belief in the interrelatedness of such aspects of growth and development as carpal age, height, mental age and school achievement, has also been well documented for more than 20 years.

Assuming this "wholeness" of child development to be tenable, many investigators have devised motor-oriented programs which have as one of their primary goals the enhancement of academic and intellectual functioning. One of these programs demanding considerable attention has been devised by Delacato (1963). Stressing the concept of "neurological organisation", the proponents of this program allege that omissions in the sequence of early motor patterns will result in subsequent behavior malfunction of one form or another. Thus a rigorous program of motor activities is prescribed that will purportedly stimulate the brain to its full functional capacity.

Kephart's Perceptual Motor Program (1960), while emphasizing the child's orientation to his environment to a greater extent than Delacato, also stresses the importance of motor experiences in the total education of the child. Similarly, the Visual-Perceptual Program devised by Frostig (1964) is based on the assumption that reading ability depends largely upon the acquisition of adequate visual-perceptual skills. Activity programs have been devised by Frostig to enhance specific visual-perceptual deficiencies (i.e., deficiencies in identifying mirror images from exact likenesses). Reading achievement is also thought to increase after exposure to a motor-oriented program emphasizing self-control (McCormick, 1968). McCormick maintains that an internalization of self-control, gained through a sequential series of physical activities, will lead to an improvement in reading ability.

An improvement in academic and intellectual functioning, through participation in the Dayton Program for developing sensory and motor skills, is also suggested by Braley and his co-workers (1968). Finally, Barsch's "Movigenic Theory" (1967) epitomizes the recent attempts at not only linking the mind and body, but also in presenting a "theory of movement" as it relates to total learning. Movigenics is

> "the study of the origin and development of patterns of movement in man and the relationship of those movements to his learning efficiency." (p. 33)

Barsch also views movigenics as

> "an effort to view man as a totality in everything he does and to account for all components of that totality in any of his performances." (p. 33)

Although there has been very little scientific data gathered under controlled conditions, the number of programs emphasizing the development of intellectual capacity through physical activity is increasing.

Need for the Study

Society has reached that point in time where experimental evidence is required in order to substantiate the heretofore subjective claims of various programs, not only in physical education, but in general education as well. School authorities, the government, and the community require that more than speculative data be produced to substantiate requests for financial and moral support of these educational programs.

Many physical educators are convinced that physical education programs can exist on the basis of psychomotor objectives alone. Promotion of the physical welfare of today's youth and adult populations alike is certainly foremost in terms of the priorities set by physical education specialists. However, since physical educators invariably include additional objectives in the cognitive and affective domains when discussing the relative merits of the physical education profession, one of two tasks must be accomplished; either the claims must be substantiated with scientific research, or those objectives which cannot be realistically and scientifically supported must be deleted. The first alternative is obviously the preferred approach in that a much stronger justification for physical education could be developed with a scientifically-based, multi-objective program than from a program with a more limited scope.

To date, the scientific evidence supporting the theories dealing with the effects of motor activity on consequent academic and intellectual functioning is extremely contradictory. Conclusive evidence has not been produced either favoring or disputing the effects of physical activity programs on academic achievement.

The educational programs which have been constructed, and the consequent evaluations of the programs, have been based primarily on atypical activities; atypical in the sense that special activities have been devised to meet particular needs. Many of the studies conducted have been clinical studies dealing with small numbers of subjects and no control groups. Little evaluation has been conducted with respect to the effects of a physical education program on academic achievement. It should be noted as well that the total elementary school age range has seldom been considered. The overwhelming majority of studies have been restricted to one, or possibly two, age groups. Of interest, too, is the fact that scientific evaluation of sex differences, in relation to motor activity programs designed to facilitate classroom learning, is sparse and conflicting. Suggestions that the male may decrease the "academic gap" between he and his female counterpart, through participation in a more male-oriented curriculum, are prevalent in the literature (Kettels, 1967; Bentzen, 1966; Minuchin, 1966).

Purpose of the Study

The purpose of this study is to investigate the effects of a one-year, objective-centered, sequential program of physical education upon the academic achievement and mental ability of male and female children enrolled in kindergarten through grade five.

Hypotheses

1. A one-year, objective-centered, sequential program of physical education will not significantly affect the academic achievement and

mental ability of elementary school children, at any level, kindergarten through grade five.

2. A one-year, objective-centered, sequential program of physical education will not affect males and females in a significantly different manner, at any level, kindergarten through grade five, with respect to academic achievement and mental ability.

Scope of the Study

Two schools, one experimental and one control, were selected from the Waverly School District. All students in kindergarten through grade five, at both schools, were evaluated with respect to the variables of total academic achievement, academic achievement sub-tests, and intelligence (N = 607).*

The Waverly School District offered an excellent opportunity to test the effects of a physical education program on academic variables in that no regularly scheduled physical education program was in operation in the elementary schools at that time. Thus, the control school was a "control" in the true sense, in that no regularly scheduled physical activity was provided for the pupils in the control school.

Definition of Terminology

For the purpose of this study, the following definitions are presented:

1. Academic Achievement: knowledges, skills and understandings commonly accepted as desirable outcomes of the major branches of the elementary curriculum (Kelly *et al.*, 1964).

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*Total N = 597 after deletions due to lack of sufficient data.

2. Mental Ability: the pupil's facility in reasoning, and in dealing abstractly with verbal, symbolic, and figural test content sampling a broad range of cognitive abilities; measurement of the "g" or general intellective ability factor (Otis and Lennon, 1967).

3. Objective-centered: based on a wide range of objectives constructed for each grade level by the members of the Battle Creek Physical Education Curriculum Project (Vogel, 1969).

4. Perceptual-motor Programs: programs emphasizing a sequence of events which include sensory stimulation, cortical processing and overt behavior (Seefeldt, 1970).

5. Experimental Physical Education Program: a special program of physical activities constructed by the Battle Creek Physical Education Curriculum Project to satisfy the physical, social, emotional and intellectual needs of the elementary school child.

6. Sequential: following a lesson-by-lesson sequence of motor activities, as established by the Battle Creek Physical Education Curriculum Project, and based upon current knowledge regarding the growth and development and principles of learning of elementary school-aged children (Vogel, 1969).

Limitations of the Study

1. The subjects were drawn entirely from the Waverly School System and thus, the generalizations may be limited by some rather specific characteristics of this community.

2. The degree of motivation throughout the testing period could not be rigidly controlled.

3. A number of testers were employed which may have produced some inconsistencies in testing procedures.

4. The effect of the tests being administered by the testing team, as opposed to the regular classroom teacher, may have increased the variability of the scores and therefore decreased the reliability of the tests.

5. Although the total sample size was 597 students, individual cell sizes were occasionally low. For example, the cell size for the experimental school, grade four females, numbered 15. A similar number was encountered in the category of control school, grade four males.

CHAPTER II

RELATED LITERATURE

The literature pertinent to the present investigation has been divided into the following two subdivisions for review:

1. Those studies investigating the relationship between intellectual functioning and motor performance.

2. Those studies investigating the effects of perceptual-motor and physical education programs upon academic achievement and intelligence.

Relationship Between Intellectual Functioning and Motor Performance

Much of the impetus for the construction of motor-based programs, aimed at the enhancement of intellectual functioning, originated as a result of the high positive correlations found between motor and mental ability in the retarded population. Francis and Rarick (1959) and Howe (1959) demonstrated clearly that intelligence, as measured by standardized intelligence tests, was positively correlated with motor items. A secondary finding of the latter author, that mentally retarded subjects appeared extremely weak in balance activities, is interesting in the light of the findings of Ismail *et al.* (1965; 1969), to be presented later in the review. Sloan (1951) produced similar data to that reported by Francis and Rarick, and Howe, upon measuring the relationship between mental deficiency and motor proficiency in 10 year old males and females. This author reported that mental defectives were significantly inferior in motor proficiency to children of average intelligence. Sloan thus concluded that motor proficiency was related to intelligence, and that motor functioning was an aspect of the total functioning of the organism. Malpass (1960) produced similar results when he compared 52 institutionalized retardates, 56 retarded children in public schools and 71 normal children on the Lincoln revision of the Oseretsky Test. No significant differences were found between the two retarded groups, but highly significant differences were noted when the scores of either retarded group were compared with the normal children. All differences were in favor of the latter group. Similarly, in an attempt to ascertain the relationship between rail-walking ability and the factors of mental age and etiological type among subnormal children, Heath (1942) tested 170 male subjects. Heath's data supported the hypothesis that there is a positive relationship between motor performance and "quality of thought."

A number of the early studies investigating the mind-body relationship in normal populations supported the assumption that a highly positive relationship did exist (Rarick and McKee, 1949; Kulcinski, 1945; Hackensmith and Miller, 1938; Jones, 1935; Rudisill, 1923). However, a greater number of researchers (Burley and Anderson, 1955; Brace, 1948; Johnson, 1942; Ray, 1940; Halsey, 1938; DiGiovanna, 1936; Seegers and Postpichal, 1936; Landis *et al.*, 1923) have found very slight, though invariably positive, correlations between the two abilities. Negative relationships are few (Slusher, 1964; Reals and Reese, 1939), but do exist.

In 1963, Ryan utilized the concept of motivation in an attempt to understand the relationship between the academic and motor domains. This author investigated the relationship between performance on a selected motor skill and (1) intellectual capacity; (2) intellectual achievement; and (3) motivation, as measured by relative intellectual achievement.

When Ryan's group (N = 80) was dichotomized on the basis of college grade point averages and entrance examinations, no differences were found between the sub-groups with respect to motor performance. However, upon classifying his subjects as to "underachievers" and "overachievers" (comparing college grades with entrance examination scores), the data indicated that the motor performance of the overachievers was significantly better than that of the underachievers. Ryan suggested that the motive to succeed in academic situations may be a more general characteristic than either intellectual or motor ability.

As a result of these earlier studies, researchers conducted further investigations, many of which attempted to explore the relationship between the intellectual domain and perceptual-motor functioning. These studies (Skubic and Anderson, 1970; Singer, 1968; Singer and Brunk, 1967; Chang and Chang, 1967) were designed to include motor items which required a greater degree of cognitive functioning than was previously expected of the subjects.

Research by Skubic and Anderson (1970) typifies the particular approach under consideration. Eighty-six fourth grade boys were studied to investigate the relationship between perceptual-motor achievement, academic achievement and intelligence. On the basis of performance on the Stanford Achievement Test, 41 and 45 pupils were categorized as low and high achievers respectively. The California Test of Mental Maturity and an 11-item perceptual-motor battery were also administered. A positive relationship was found between intelligence and perceptual-motor ability ($r = .491$) and between academic achievement and perceptual-motor ability ($r = .500$). In discussing these relatively high correlations, the authors attributed them to their choice of perceptual-motor items:

> "...in the battery of tests used in the present study, an attempt was made to eliminate problems encountered in previous research. Tests were constructed for the specific age level involved and were designed to present a challenge to the subject both mentally and motorically." (p. 418)

Singer and Brunk (1967) investigated the relationship between intelligence and the performance of a highly perceptual task, the Figure Reproduction Test. The authors found that although the majority of the correlations between the academic variables and the Figure Reproduction Test were significant, they accounted for very little of the total variance. In fact, the authors noted that their highest correlation (r = .29) accounted for only .08 of the total variance. They thus concluded that the relationship, though significant, was highly suspect.

Some researchers (Chang and Chang, 1967; Singer, 1968) have investigated the hypothesis that higher correlations may be found for younger subjects, as opposed to older children, with respect to the relationship between perceptual-motor and academic skills. Chang and Chang (1967) found that although higher relationships between visuomotor and reading skills were recorded for second graders, these coefficients were not significantly different from those obtained by those in grade three. In a similar study, Singer (1968) investigated the relationship between academic achievement, physical characteristics and perceptual-motor abilities within and between selected groups of third and sixth grade children (N = 42 and 30 respectively). The author found that even though a relatively low coefficient of .35 was required for significance, few coefficients for either grade exceeded this figure. In addition, no trends were apparent even where statistical significance was reached. Thus, in rejecting the hypothesis that the interrelationships between perceptual-motor, physical and cognitive variables would

be greater at the lower level, Singer concluded that individual abilities are fairly well task-specific, even with youngsters in the third grade. A second hypothesis, that those perceptual tasks with high intellectual components would correlate highest with academic achievement, was also rejected.

The last decade has seen a shift from the consideration of intelligence, perceptual-motor performance and academic achievement as total entities, to a consideration of the sub-components of these general classifications. A number of studies have been reported concerning auditory-motor and visual rhythm, and their relation to reading achievement. Birch and Belmont (1965) produced data indicating a strong relationship between perceptual ability, as measured by auditory-visual integration and reading achievement. More specifically, the perceptual test required the subject to choose one of three printed dot patterns that corresponded to a stimulus pattern tapped out with a pencil. Utilizing the same perceptual task to measure auditory-temporal rhythm perception, Sterritt and Rudnick (1966) found this aspect of perception related to reading achievement in fourth grade boys.

Further study, by Werner *et al.* (1967), did little to clarify the issues at hand. These authors investigated the effectiveness of the Bender-Gestalt (B-G) test in identifying 10 and 11 year old children with reading problems (N = 750). The investigators found that although the incidence of reading problems increased with error scores on the perceptual task (B-G), the majority of children with reading problems had adequate B-G reproductions. However, most poor B-G reproductions were found among children of below average intelligence.

Other investigations focused upon spelling and language problems, as well as those problems experienced in reading, and the relationships

of these problems to perceptual-motor functioning. Coleman (1968) studied 87 children in grades one through six, all of whom possessed severe language and reading deficits. Upon evaluating for visual and visual-perceptual development, it was found that almost 50% of the sample had visual-perceptual dysfunction judged severe enough to significantly impede learning. Similarly, Bannatyne and Wichiarajote (1969) found significant relationships between unlearned ambidexterity and spelling ($r = .42$) and unlearned ambidexterity and balance ($r = .28$). The authors inferred a superior motor coordination between the two sides of the body and between these two variables and the eyes. In other words, the inference is that the superior speller possesses superior visuo-motor coordination. The authors concluded by suggesting that "spelling as an encoding function is heavily depending on automized motor/kinesthetic/ praxic processes" (p. 9).

Physical education specialists have also been active in the assessment of relationships between perceptual-motor and academic functioning. Testing 172 male and female subjects, Plack (1968) found high positive relationships between achievement in reading and selected motor skills for children in grades one, three and five. This author also noted that mean motor skill scores were significantly different among high, middle and low reading achievement groups. More specifically, differences between the high and low reading achievement levels were generally significant, those between the high and middle were generally significant, and those between the middle and low were generally not significant. The work of Trussel (1969), however, yielded much lower correlations, with respect to the relationships between reading achievement, visual perception, motor development and eye-hand dominance. Seventy-five first and second grade children were tested on sub-tests of the Metropolitan

Achievement Test, reading, the Lincoln-Oseretsky Motor Development Scale, the Frostig Developmental Test of Visual Perception and two perceptual-motor tasks, the pursuit rotor and the stabilometer. Although correlations among many variables were significant, none were high enough for reliable prediction of one variable from another. Factor analysis failed to provide factors indicative of interrelationships among elements of visual, motor and reading functions.

Attempts at predicting scores on one variable from results obtained on one or more other variables have been alluded to throughout this review of literature. At this point, the author would like to discuss a number of research findings which place a greater, though certainly not total, emphasis on the prediction of academic variables from information gathered with respect to motor variables.

Ismail *et al.* (1963) initiated a group of "prediction" studies, in investigating the relationships between academic achievement, intelligence and motor aptitude. One hundred twenty 10, 11 and 12 year old males and females comprised the sample for this study. This investigation indicated that motor aptitude can in fact predict, with some measure of success, achievement scores in academic variables. The authors noted (a) that intelligence scores could be predicted more accurately from motor aptitude test items than could academic achievement scores, and (b) both intelligence and academic achievement scores could be predicted more accurately by motor aptitude test items in high and low achievers than in medium achievers. No sex differences were noted with respect to prediction of academic variables from motor variables. Ismail and Gruber (1965) conducted a follow-up study which not only substantiated the above findings, but added a new dimension. The authors reported that

coordination and balance items, in that order, were the most beneficial motor performance items in predicting academic achievement.

Three subsequent studies (Ismail *et al.*, 1969; Yoder, 1968; Bengston, 1966) tended to support the results just presented. Ismail *et al.* (1969) provided a cross-validation of their previous work, using as subjects 94 primary school children from London, England. This research also pointed to a substantial and positive association between motor aptitude, especially with respect to coordination and balance, and well established measures of intelligence and scholastic performance. Yoder (1968), utilizing a sample of 240 fourth and fifth grade boys and girls, found the same type of factors and relationships as those reported by Ismail. Bengston (1966) also confirmed the consistently positive relationships found by the other investigators. The latter author examined the interrelationships among perceptual-motor development, motor performance, school achievement, and intelligence, using slightly younger children (9 years), fewer subjects (N = 55), and limiting the study to males only. Although the relationships between school achievement subscores and motor performance were generally low, the relationships between the Purdue Perceptual-Motor Survey sub-tests and the total school achievement were relatively high and positive.

Not all studies tend to support the hypothesis that it is possible to predict academic scores from scores obtained on motor tasks. Research by Trussell (1969) and Bihlmeyer (1965) suggests the predictability of academic variables from motor performance measures to be virtually zero. The former author (Trussel, 1969) stated that:

> "It would be equally effective and far more expedient, to predict the performance of the child on the basis of age, rather than by employing any of the test batteries considered here." (p. 386)

The test batteries referred to included the Metropolitan Reading Test, Lincoln-Oseretsky Motor Development Scale, Frostig Developmental Test of Visual Perception, and pursuit rotor and stabilometer tasks.

Bihlmeyer (1965) produced data which cast doubt on the reliability of predicting academic scores from motor variables. This author utilized the Lincoln-Oseretsky Motor Development Scale in an attempt to predict the academic achievement of fourth grade boys. He concluded that it did not possess a sufficient degree of relationship to reading, writing, drawing, and general educational achievement to be of value as a predictor of performance. It is of interest to note that both studies failing to substantiate the existence of a relationship between motor and academic variables, utilized the Lincoln-Oseretsky Motor Development Scale as the criterion measure with respect to motor performance.

The Effect of Perceptual-Motor Programs on Academic Achievement and Intelligence

Many researchers have devised perceptual-motor training programs which have as their ultimate goal the enhancement of academic functioning (McCormick, 1968; Barsch, 1965; Frostig, 1964; Delacato, 1963; Kephart, 1960). Evaluation of these programs has produced a number of studies, some supporting and others refuting the claims of the originator of the program cited.

One of the earliest programs to be developed was that proposed by Delacato (1963), based on the concept of "neurological organization." Delacato (1966) states that the basic difference between the nervous system of man and that of lower animals lies not in the number of cells, but in the differentiation and organization of those cells. Thus, the concept of neurological organization, in addition to neurological development, has to be recognized. Further, neurological organization is a "whole." If any aspect is not complete, further development will be adversely affected. Delacato also states that:

> "Deprivation, trauma or enrichment all affect the development and organization of the nervous system. Children who have problems with reading have either been traumatized or have been deprived environmentally, resulting in a lack of complete Neurological Organization which, in turn, creates the reading problem." (p. 5)

A number of studies have attempted to evaluate the validity of Delacato's theory of neurological organization. Robbins (1966), in the first of two investigations, selected one second grade class from each of three Chicago elementary schools. The first class (N = 43) served as a control group and carried on its normal curriculum. The second class (N = 38) was designated as the experimental group and, in addition to its regular curriculum, was subjected to a program consistent with the theory of Delacato. In order to control for experimental effect, the third class (N = 45) undertook a general program of activities not thought to be correlated with reading achievement. The results of the three-month program suggested that creeping was not related to reading beyond chance expectancy, nor did mean reading differences between subjects who were lateralized and those who were not lateralized exceed chance expectations. Further, mean post-test differences in reading between the group exposed to the experimental program and the other two groups were not significant. If the reader is willing to accept the limitations of non-random selection of subjects and differential teaching skills among the three teachers involved, it must be concluded that the addition of the experimental program to the regular curriculum in no way enhanced the reading or lateral development of these second grade children. Similar findings resulted from a follow-up study (Robbins, 1967) employing retarded readers (N = 150) ranging in grade level from three to nine. Experimental evidence did not support the postulated relationship between neurological organization (as measured by creeping and laterality) and reading achievement. The data of O'Donnell and Eisenson (1969) tended to support the findings of Robbins, although some measure of success was noted in terms of producing changes in reading ability through neurological training. Utilizing a sample of 678 disabled readers (C.A. = 84-120 months), the authors noted that neither reading ability nor visual-motor integration were significantly higher in the experimental groups than in the controls. However, in both cases the experimental group did score higher on the post-tests for both reading and visual-motor integration.

The Perceptual-Motor Program designed by Kephart (1960), while being more difficult to investigate, has nevertheless been scientifically evaluated by some researchers (Brown, 1968; Painter, 1966; Falik, 1969) in an attempt to determine the relative effectiveness of perceptual-motor activity toward enhancing academic potential. Difficulties have arisen, as noted,

> "...due to the inability of investigators to provide a rationale for a quasi-theoretical base. The lack of a well defined methodology, with the implication that a number of skills may be utilized to enhance various perceptual abilities, may also have discouraged scientific evaluation of the program." (Seefeldt, p. 84)

Brown (1968) used 56 below-average readers as his experimental group and gave these subjects special perceptual-motor training, largely based on the activities suggested by Kephart (1960). Ninety-eight control subjects were given a physical education program which emphasized development of basic skills, with little emphasis on the development of perceptual-motor skills. The author's t-test analyses indicated that the experimental group did improve significantly in perceptual-motor skills and, although greater gains in reading achievement were recorded by the experimental pupils than by the control group, significant differences were not detected.

Two studies (Painter, 1966; Falik, 1969) on kindergarten children provide the reader with contradictory evidence concerning the effects of perceptual-motor programs. Painter, while not directly evaluating the effects of Kephart's Perceptual-Motor Program, investigated the effects of a program based on nine movement areas of Barsch's Moviegenic theory (1965) and on suggestions from Kephart (1960). Although significant differences were found in all areas, specifically the ability to draw a human figure, distortions of body-image concept, visual-motor integrity, sensory-motor spatial skills and psycholinguistic abilities, caution should be exercised in view of the small sample size (10 experimental, 10 control) and the lack of control for experimental effect. Falik's kindergarten study (1969) failed to substantiate the findings of Painter. The former researcher's results indicated that the experimental group, participating in a perceptual-motor program fashioned after that of Kephart, was not significantly superior in reading ability to the control group, either at the end of kindergarten or upon retesting in the middle of grade two.

Perhaps more investigators have concerned themselves with Frostig's Visual-Perceptual Training Program (Frostig, 1964) than with any other single motor-oriented program. Jacobs (1968a) conducted one such evaluation on kindergarten, pre-kindergarten and first grade children (N = 500). Co-variance analyses indicated that children taking the Frostig program did significantly better on the Frostig Visual-Perceptual Test than did controls, with largest gains being made by those in first grade. However, no differences in reading readiness were found, although only kindergarten pupils were evaluated on this variable. A follow-up study (1968b) was undertaken in an attempt to determine the predictive validity of the Frostig tests upon future reading achievement. The findings indicated that not only did pupils who took the Frostig program encounter little advantage in terms of future reading achievement, but the predictive ability of both the Frostig and the Metropolitan Reading Readiness Test was very low. However, as was shown in the previous work, pupils who took the Frostig program in pre-kindergarten, kindergarten and first grade tended to show higher levels of visual-perceptual performance on the Frostig test. Thus, the results of the two studies lead the reader to believe that if one's goal is simply to increase the visual-perceptual quotient of children, the Frostig program is beneficial. However, if the goal is to increase reading ability beyond that normally expected, the evidence provided by Jacobs is far from supportive. Identical conclusions can be drawn from the work of Rosen (1966). Studying a group of 637 first grade boys and girls, Rosen found significant differences between treatment groups (Frostig and controls) in certain post-training perceptual abilities without concomitant effects on reading achievement. Rosen concluded that additional time devoted to reading instruction was more important for improvement in reading than time devoted to the types of perceptual training utilized in the investigation.

Working with second graders (N = 71), Olson (1966) found that although the Frostig test had some value as a predictor of general achievement, reading achievement was predicted to a greater extent by more traditional diagnostic tests. Additional findings indicated, however, that four of the five Frostig sub-tests showed significant relationships with specific reading abilities. These statistically "significant"

relationships, however, often accounted for less than fifteen percent of the variance. For example, many of the statistically significant correlations were in the neighborhood of .31 to .38. It should be noted also that the correlations obtained in Olson's study, although often significant, did not approach those presented by Bryan (1969). The latter author presented some evidence concerning the effectiveness of the Frostig test in predicting reading readiness in kindergarten (.70) and grade one (.46), as well as significant relationships in grade one between Frostig scores and California Achievement Vocabulary (.50) and Comprehension (.51).

Utilizing the factor analysis technique, Boyd and Randle (1970) found that the Frostig Test of Visual Perception did not appear to reflect essentially different and independent perceptual abilities. Thus, the content validity of the Developmental Test of Visual Perception was seriously questioned. However, further analysis of both the Frostig Test and Visual Perceptual Program continued. In 1968, Lewis conducted a pilot study to determine if the Frostig program could be instrumental in improving perceptual ability as reflected in reading achievement gain. Five second grade youngsters, all diagnosed as having reading disability, were given a ten-week program consisting of three hourly sessions each week. Although improvement was noted in each area of visual perception, the small N prohibited the attaining of statistical significance. Nevertheless, the findings were similar to those reported earlier by Jacobs (1968a, 1968b) and Rosen (1966). More interesting perhaps were those gains in reading ability reported by Lewis. A mean percentile gain of 40.2 for the 5 subjects was significant at the .01 level. However, the small N tends to cast considerable doubt on this unusual finding.

A different approach was taken by Fretz *et al.* (1969) in a study which investigated the effects of therapeutic play on the intellectual and perceptual-motor development of maladjusted children. The findings indicated that while the changes in perceptual-motor performance, as measured by the Frostig and Bender-Gestalt, were significant in favor of the experimental group, changes in intelligence were not nearly so evident. Performance IQ's increased significantly for the controls. In fact, the sub-test changes in both the Performance and Verbal IQ's revealed a mixed pattern of significant changes.

The Frostig program has also been evaluated with respect to its effect on educably mentally retarded children (Alley, 1968). The perceptual-motor training program was conducted daily for two months, during which time the controls spent a comparable amount of time in regular special education activities. Covariance analysis suggested that there were no advantages to be derived by EMR children from the Frostig visual-perceptual program, with regard to subsequent sensorimotor, visual-motor, perception and concept formation performance, over general special education classroom activities.

To date, little scientific evidence has been produced to substantiate the success of McCormick's "attention-orienting" program (1968), from which improvement in reading skills is alleged to be concomitant with the development of self-discipline in the presence of surrounding stimuli. To evaluate their own program, McCormick *et al.* (1968) matched forty-two underachieving grade one children for age, sex, intelligence and Lee-Clark reading grade level. Group one received the perceptual-motor program in 45-minute periods, twice a week for seven weeks. The exercises began with cross-lateral crawling and proceeded through walking, balancing, jumping rope and other similar exercises. Group two, formed to control for "extra-activity" effects, received standard physical education training. A third group formed the control group proper and thus received no extra training or activity. The data were analyzed for significance by the Wilcoxen Matched-Pairs Signed Rank Test and the results indicated statistically significant gains in reading achievement for the group which received the perceptual-motor training but not for either of the two control groups.

A number of studies have attempted to explore the effectivness of perceptual-motor training procedures other than those specifically set down by Delacato, Kephart, Barsch, Frostig and McCormick. In a 1963 study, Chansky (1963) investigated whether children trained to perceive with greater precision would subsequently become better achievers. Underachieving children received training in reproducing designs with blocks differing in size, shape and color. Upon analysis, it was found that trained children, in contrast to the controls, improved in both reading and spelling. Also noted was the fact that many of the experimental subjects increased as much as two standard errors of measurement in intelligence scores. A follow-up study (Chansky and Taylor, 1964) of a similar nature, conducted on educably mentally retarded children, produced similar results. An additional finding of note was the fact that group training appeared to be as effective as individualized training in producing achievement and intelligence test improvements.

Changes in intelligence scores as a result of visual-perceptual training were also the concern of Boger (1952). Working with elementary pupils, the author's experimental group participated in a visual-perceptual program consisting of work with such materials as hidden picture puzzles, directional drawings, visual crossword puzzles, jig-saw

puzzles and other similar tasks. In general, the exercises were devised to provide practice in following directions, noting details, perceiving spatial relationships and developing increased eye-hand coordination. Covariance analysis indicated that the exercises did cause an increase in intelligence scores of rural elementary school pupils. In addition, retests five months later showed that the experimental group maintained their superiority with respect to intelligence scores.

From the literature cited, it would appear that most children who are given extensive training in perceptual and motor tasks are able to: (a) show an improvement in tasks involving identical cognitive processes, e.g., left-right discriminations in perceptual forms such as the Frostig training procedures, and (b) show no significant increase in their school achievement.

Bibace and Hancock (1969) conducted a study to examine the above possibilities. More specifically, the authors conducted a pilot study to test the theoretical assumption of the mastery of lower (perceptual-motor) processes as necessarily preceding the mastery of higher (cognitive) processes, and hence academic achievement. It should be noted at this point that this theoretical assumption is extremely important in that it has shaped both the methodological assumptions guiding research in the field and the clinical-pedagogical efforts of various specialists who attempt to offer remedial programs for children with learning disabilities. Examples of both cases, many of which have formed the basis of the review to this point, are prevalent.

The experimental design employed by the authors consisted of three variables: age, level of scholastic achievement, and level of perceptual-motor achievement. Boys aged 7-8 and 12-13 were selected in order that the assumption could be investigated for both those who had only recently acquired the higher cognitive processes and those in whom such processes should have been well-established. Since this study was a pilot investigation, only 8 boys were tested. In addition to the Kephart Perceptual-Motor Survey and school grades, data were collected on learning tasks, each of which was developmentally organized such that lower (perceptual-motor) or higher (conceptual) means of functioning might be recognized in the performance. The authors found that those who were high in scholastic achievement, irrespective of whether they were high or low in perceptual-motor functioning, utilized conceptual means rather than perceptual means on the three experimental tasks. Conversely, subjects low in scholastic achievement relied primarily on perceptual means whcn faced with the experimental tasks. The authors concluded that the the theoretical assumption of the mastery of lower processes as necessarily preceding the mastery of higher processes must be more fully researched.

While the effects of various types of perceptual-motor programs, many employing widely varying techniques and equipment, have been extensively investigated, the effects of regular physical education programs upon the academic functioning of the child are still unknown. In fact, to this author's knowledge, the only scientific attempt to evaluate the relative effectiveness of a well-organized regular physical education program on intelligence and academic achievement was that conducted by Ismail (1967). The sample consisted of ten, eleven and twelve year old subjects (N = 142). Experimental and control groups were formed by matching according to intelligence. Three sub-groups were formed within both the experimental and control groups and labelled "high achievers" (N = 18), "medium achievers" (N = 44), and "low achievers" (N = 9). Analysis of variance produced only two significant F values

with respect to intelligence and one of these, "levels of achievement", was obviously expected. The second significant F value, "treatments by sex interaction", indicated that higher mean intelligence scores in boys were associated with the experimental group. Opposite findings were obtained for girls. The results obtained from investigating the relative effectiveness of the physical education program on academic achievement presented a somewhat different picture. Together with the expected significant F value for "levels of achievement", the authors also found significance for the "treatments" main effect, in favor of the experimental group. This indicated that the physical education program had a significantly favorable effect on the academic achievement of children.

Summary of Related Literature

The relationships noted between academic and motor domains are generally positive, though rarely high enough for predictive purposes. The highest relationships occurred when extreme population groups were compared. For example, relationships of a high magnitude are often noted when comparing retarded to normal populations in motor ability. Similarly, studies dichotomized as to "high" and "low" achievers often produce high positive relationships with respect to academic and motor functioning. Lastly, higher positive relationships are invariably found in studies which have investigated a retarded population alone, rather than those studies conducted on normal populations.

In reviewing the large number of studies investigating the effects of perceptual-motor programs upon academic achievement and intelligence, it appears that the principle of specificity must be upheld. For the most part, children receiving perceptual-motor training improve most in perceptual-motor skills. Those children receiving extra reading practice appear to improve most in reading skills. Exceptions are noted, however, when investigating retarded readers, in which case significant gains in reading, or other academic skills, are often in evidence. However, in general, the more closely related the learning experience is to the ultimate task, the more significant are the gains noted.

In a great number of the studies reviewed, one or more of the following limitations were evident:

a) lack of a control group

b) very small sample size

c) lack of control for the "Hawthorne Effect

d) lack of a well-defined methodology (i.e., specific tasks, methods, etc.) with which to conduct an experimental program.

CHAPTER III

RESEARCH METHODS

The purpose of this study was to determine the effects of a one year, objective-centered, sequential program of physical education on the academic achievement and mental ability of male and female children enrolled in kindergarten through grade five.

Experimental Design

The Subjects

The children involved in the study were obtained from the Waverly School District, to the west of Lansing, Michigan. The elementary schools of the district were studied to determine if it was possible to locate two schools equated with respect to facilities, qualifications of teaching staff, socio-economic status, and caliber of student. Two such schools, namely Elmwood and Colt Elementary Schools, were identified by the research team from Michigan State University and the superintendant, principals and teachers of the Waverly School System. Elmwood Elementary School was identified as the experimental school by random selection.

Complete data were obtained for 597 children. This figure includes all subjects, grades K-5, at both schools, with the exception of those for whom insufficient data were available.* The 597 children were distributed as indicated in Table 1.

Table 1. Cell sizes by grade and sex for experimental and control schools (N = 597)

	Experimental School		Control School	
	Male	Female	Male	Female
Grade K	33	30	19	29
1	37	25	27	30
2	16	21	25	30
3	27	21	26	25
4	21	15	15	20
5	26	31	18	20

Collection of Data

The testing team was comprised of two professors, three doctoral candidates and four master's students from the Department of Physical Education, Michigan State University. The master's candidates were trained by the five senior investigators prior to the testing period. Parents of the children enrolled in both schools served as recorders.

The initial round of testing began in early September and continued for one week at each school. The tests were administered in the regular classrooms by a member of the testing team.** When possible, only one testing session was administered to each class per day. When the number of sub-tests required that more than one sub-test per day be administered,

*A variety of reasons resulted in ten subjects being dropped from the initial population of 607 students. By far the most common was the fact that some subjects moved from the area between testing sessions. Thus, the total sample (N = 597) included kindergarten (111), grade one (119), grade two (92), grade three (99), grade four (71), grade five (95).

**The pre-tests for grades 2 and 4 were administered by the Waverly School System as these two grades were scheduled by the School Board to be tested at that time (September 1969).

one session was scheduled in the morning and one in the afternoon. Make-up testing of absentees was conducted on an individual basis by a member of the testing team. Procedures for administration were as outlined in the manuals provided by the publishers, Harcourt, Brace and World, Inc. The post-program testing period began in early June and continued for one week at each school.

<u>The Tests</u>

Three tests, the Stanford Early School Achievement Test, the Stanford Achievement Test and the Otis-Lennon Mental Ability Test, formed the test battery administered to the children of grades K-5. Different forms of the same test were administered for pre-test and post-test data collection. Table 2 lists the tests administered to each grade at each testing session and Table 3 provides a summary of the sub-tests for academic achievement administered at each grade level.

The Otis-Lennon Mental Ability Test was utilized in grades 1-5 and for the post-testing of the kindergarten children (no pre-test for mental ability was available for this group). Although many of the mental ability tests were administered in a number of parts, the total score was used to provide a comprehensive assessment of general mental ability or scholastic aptitude.

Two of the most fundamental requirements of any measurement are that it be valid and reliable. Reliability coefficients and means of attaining validity for the Stanford Early School Achievement Test, the Stanford Achievement Test and the Otis-Lennon Mental Ability Test are presented below:

a) Stanford Early School Achievement Test: Presented in Table 4 are the split-half (odd-even) reliability coefficients corrected by the

Table 2. Academic achievement and mental ability tests (pre and post) administered to each grade

Grade	Achievement Test	Fall (Pre-Test) Form	Mental Ability Test	Form
Kg	SESAT:* Level 1		None	
1	SESAT: Level II		Otis-Lennon: Primary II	J
2	SAT:** Primary I	W	Otis-Lennon: Elementary I	J
3	SAT: Primary II	W	Otis-Lennon: Elementary I	J
4	SAT: Intermediate I	W	Otis-Lennon: Elementary II	J
5	SAT: Intermediate I	W	Otis-Lennon: Elementary II	J
Grade	**Achievement Test**	**Spring (Post-Test) Form**	**Mental Ability Test**	**Form**
Kg	SESAT: Level I		Otis-Lennon: Primary I	K
1	SESAT: Level II		Otis-Lennon: Elementary I	J
2	SAT: Primary II	W	Otis-Lennon: Elementary I	K
3	SAT: Primary II	X	Otis-Lennon: Elementary I	K
4	SAT: Intermediate I	X	Otis-Lennon: Elementary II	K
5	SAT: Intermediate II	W	Otis-Lennon: Elementary II	K

*Stanford Early School Achievement Test. **Stanford Achievement Test.

Table 3. Academic achievement sub-tests administered by grade

Kg	**Grade 1**
1. The Environment	1. Word Reading
2. Mathematics	2. Paragraph Meaning
3. Letters and Sound	3. Vocabulary
4. Oral Comprehension	4. Spelling
	5. Word Study Skills
	6. Arithmetic
Grade 2	**Grade 3**
1. Word Meaning	1. Word Meaning
2. Paragraph Meaning	2. Paragraph Meaning
3. Spelling	3. Science and Social Studies Concepts
4. Word Study Skills	4. Spelling
5. Arithmetic	5. Word Study Skills
	6. Language
	7. Arithmetic Comprehension
	8. Arithmetic Concepts
Grade 4	**Grade 5**
1. Word Meaning	1. Word Meaning
2. Paragraph Meaning	2. Paragraph Meaning
3. Spelling	3. Spelling
4. Word Study Skills	4. Language
5. Language	5. Arithmetic Comprehension
6. Arithmetic Comprehension	6. Arithmetic Concepts
7. Arithmetic Concepts	7. Arithmetic Application
8. Arithmetic Application	8. Social Studies
	9. Science

Spearman-Brown Prophecy Formula. The coefficients obtained are of the magnitude expected since each sub-test is intentionally short, and reliability is expected to increase with test length. No mention is made of validity with respect to the SESAT battery, although content or curricular validity is undoubtedly assumed.

b) Stanford Achievement Test: The medians of the split-half reliabilities obtained on the sub-tests for each of grades 1-5 respectively were .89, .89, .91, .91, .89. For complete reliability data, by sub-test

Table 4. Reliability coefficients for each sub-test of SESAT: Level I*

Subtest	Kg	Grade 1
1. The Environment	.85	.82
2. Mathematics	.79	.82
3. Letters and Sounds	.79	.89
4. Oral Comprehension	.76	.77

*Reliability coefficients for Level II are presently being constructed and thus are not available at this time.

and by grade, the reader is referred to Kelley *et al.* (1964), Stanford Achievement Test: Technical Supplement (Harcourt, Brace and World, Inc., 1966). Content or "curricular" validity is assumed by the authors to have been met.

c) Otis-Lennon Mental Ability Test: Presented in Table 5 are the split-half (corrected by the Spearman-Brown Prophecy Formula) and the

Table 5. Split-half and Kuder-Richardson reliability coefficients by grade (Form J)

Grade*	Reliability Coefficients	
	Split-Half	K-R #20
1	.90	.90
2	.89	.88
3	.92	.91
4	.94	.93
5	.95	.95

*No coefficients available for kindergarten.

Kuder-Richardson #20 reliability coefficients. The validity of the Otis-Lennon tests is based on content or "curricular" validity.

With respect to the scoring of the tests, the pre-tests for grades 2 and 4 were scored by the classroom teachers in the two schools. The pre-tests for grade one were machine-scored by the publishing company as these data were to be incorporated in national norms. The remainder of the pre-tests and all the post-tests were scored by the research team from Michigan State University.

The Program

The children in grades K-5 attending the experimental school received a one-year physical education program based on the curriculum developed for the Battle Creek Public School System.* This curriculum was constructed jointly, over a four-year period, by physical education specialists at Michigan State University and the members of the Battle Creek Physical Education Curriculum Project from the Battle Creek Public Schools. The program was a research-based, objective-centered, sequentially developed program of physical education, covering a wide range of skills and activities. Although a great deal of emphasis was placed on the development of perceptual-motor skills, the program can in no way be compared to those programs specifically constructed to increase perceptual-motor functioning (McCormick, 1968; Delacato, 1966; Barsch, 1965; Frostig, 1964; Kephart, 1960). Stress was placed on the total development of the child and particular activities were presented to enhance social, emotional, cognitive and physical functioning. The activities presented were consistent with the objectives and sequences

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*Unpublished material, Curriculum Study Center, Room 40, Women's Intramural Building, Michigan State University, East Lansing, Michigan.

previously determined by the Battle Creek Curriculum Project. Thus, the present age, grade level and state of the learner dictated the particular activities that he or she would undertake at each stage of his or her development.

The experimental physical education program was conducted from September 1969, immediately following the pre-testing period, to May 1970, immediately preceding the post-testing period. The number and duration of classes was administered according to the following schedule:

Grade K:	3 classes/week	20 minutes/class
1:	3 classes/week	30 minutes/class
2:	3 classes/week	30 minutes/class
3:	2 classes/week	35 minutes/class
4:	2 classes/week	35 minutes/class
5:	2 classes/week	45 minutes/class

Two teachers, both qualified female physical education instructors, were employed on a half-time basis by the Waverly School District. The teachers were rotated such that each instructor was exposed to all grade levels, thus helping to eliminate the teacher bias. An established elementary school teacher at the experimental school was assigned as a coordinator for the program. The control school received no formal physical education classes throughout the entire duration of the study.

Statistical Treatment of the Data

Chi square tests of hypotheses of no association between dependent and independent variables were calculated for each grade level. These tests were computed in order to provide statistical evidence as to the appropriateness of covariance analyses in this study.

Step-wise regression analyses, indicating the contribution of each independent variable, were calculated for each co-variable used in the analysis, i.e., a separate step-wise regression analysis was computed for each sub-test at every grade level. These analyses were conducted in order to obtain an estimate as to the necessity, or contribution, of each co-variable used in the study.

A series of multivariate covariance analyses were employed to determine if significant differences existed between the control and experimental groups with respect to the dependent variables, the post-test academic achievement and mental ability scores. Pre-test scores were used as the independent variables (co-variates) in the analyses. Each grade was treated separately in a multivariate analysis, and within each grade, males and females were analyzed individually. The academic achievement sub-test scores were converted to standard scores (T-scores) in order to obtain a measure of total academic achievement. However, the multivariate covariance analysis was carried out on the raw scores obtained for mental ability.

The nature of the dependent variables necessitated that two separate multivariate covariance analyses be conducted for each hypothesis, at all grade levels. Total academic achievement and mental ability were investigated in one analysis and the academic achievement sub-tests comprised the second analysis. The linear relationship between the academic achievement sub-tests and total academic achievement precluded the use of a single multivariate covariance analysis.

The multivariate covariance program yielded three separate F values: a) multivariate; b) univariate; and c) step-down F values. The step-down F values were included in order to obtain an estimate of the relative contribution of each variable involved in the analysis. It is possible to enter the variables to be analyzed in any order. For example, if

AAS3* was entered as the fifth variable in the analysis, the experimentor would be able to investigate the relative contribution of AAS3 after accounting for the variability due to the first four variables.

Upon completion of the initial covariance analyses, all programs were re-ordered on the basis of the step-down F values, in a further attempt to obtain reliable estimates of the contribution of each variable involved. The variables were re-ordered on the basis of their contribution to the overall multivariate F value. Those sub-tests which appeared to contribute the most to the variability noted in the multivariate F value were placed first in the subsequent analysis. Thus, the variables were ranked in order, from highest to lowest, with respect to their overall importance in accounting for the multivariate F value obtained. Only those sub-tests which obtained a step-down value of $p<.10$, for at least one of the hypotheses under consideration (school, sex, interaction), were included in the re-ordered program.

When interpreting the F values obtained in the re-ordered covariance analyses, emphasis was placed firstly on the multivariate F values, secondly on the univariate values, and finally on the step-down values. In fact, due to the susceptibility of the step-down F values to the order in which the variables were placed in the analysis, little attention was placed on these values once the re-ordering had been completed. In particular instances in which the univariate values were very close to the level of significance required for rejection of the null hypothesis, step-down values were consulted in making the decision with respect to rejecting or accepting the null hypothesis in question.

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*Academic achievement sub-test three.

The multivariate alpha level necessary for rejection of the null hypothesis was set at $\alpha = .05$. Similarly, the step-down values (when consulted) were also set at $\alpha = .05$. The univariate values were set at $\frac{\alpha}{n}$, where $\alpha = .05$, and n = the number of variables (tests) involved in the analysis. For example, if the re-ordered covariance program contained five sub-tests, the alpha value required for rejection of the null hypothesis would be .01. This procedure is in accord with that set forth by the Bonferroni Equality (1966), in that the Bonferroni effect states that the division of the alpha level (i.e., $\frac{\alpha}{n}$) does not need to be made in equal amounts. In other words, where the univariate alpha is equal to .01, as noted above, this value of .01 can be adjusted slightly to allow univariate F values that come very close to .01 to be rejected. Thus, in this paper, other criteria are utilized (step-down F values) in making the decision of whether or not to reject the null hypothesis in particular cases where the univariate F value approaches that value required for rejection (i.e., $\frac{\alpha}{n}$ or, in this case, .01).

All computations were carried out on the CDC 3600 computer, with the exception of the T-score conversions, which were computed on the CDC 6500 computer, at Michigan State University.

CHAPTER IV

RESULTS

The results of this study will be presented in the following order:

1. The results of Chi Square tests of hypotheses of no association between independent and dependent variables.

2. The results of step-wise regression analyses indicating the contribution of each independent variable.

3. Separate analyses of covariance, by grade, presented in the following order:

a) Least square estimates, adjusted for covariates;

b) Pre-test and post-test cell means for experimental and control schools;

c) Multivariate* and univariate covariance tests for School effects: Academic Achievement Total and Mental Ability;

d) Multivariate and univariate covariance tests for School effects: Academic Achievement sub-tests;

e) Multivariate and univariate covariance tests for Sex effects: Academic Achievement Total and Mental Ability;

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*In the case where only one variable was analyzed, a univariate analysis is presented alone.

f) Multivariate and univariate covariance tests for Sex effects: Academic Achievement sub-tests;

g) Multivariate and univariate covariance tests for School x Sex interaction: Academic Achievement Total and Mental Ability;

h) Multivariate and univariate covariance tests for School x Sex interaction: Academic Achievement sub-tests.

4. Summary Table of Results.

Chi Square Tests of Hypotheses of No Association Between Dependent and Independent Variables

The results of Chi Square tests of hypotheses of no association between dependent and independent variables indicated P values less than .0001, for all grades. It was thus concluded that the covariance analyses were appropriate for use in this study.

Step-Wise Regression Analyses

The results of step-wise regression analyses depicting the contribution of each independent variable (co-variable) indicated P values less than .01 for all but two co-variables used across all six grades. The majority of the P values were less than .0001. It was thus concluded that all the co-variables used, with the exception of two, were necessary for the analysis of the data in this study.

Multivariate and Univariate Analyses of Covariance for School, Sex and Interaction Effects

Least square estimate tables will be presented for each grade level. With respect to interpretation, the sign (minus or plus) indicates the direction of the difference between a) experimental and control schools and b) males and females. For the main effect of Schools, a minus sign indicates that any difference, whether significant or not, is in favor of the control school. For the main effect of Sex, a minus sign indicates that the difference is in favor of the females. Plus values indicate differences in favor of the experimental school, or in the case of the Sex main effect, males. The numerical values indicate the magnitude of the differences. However, significant differences are noted in the tables that follow (univariate and multivariate analysis of covariance tables). The reader, finding a significant difference, should then consult the least square estimates table in order to locate the direction (experimental-control, male-female) and magnitude of the difference. Thus, the least square estimates tables, presented at the beginning of the analyses for each grade level, are for further reference, once significant differences have been located in the covariance analyses.

Tables of cell means for experimental and control schools, males and females, are also presented for each grade level. This allows the reader to refer to the actual cell means for pre-test and post-test scores. Thus, further evidence is provided for use in interpreting any significant F values noted in the following covariance analyses.

Kindergarten

A summary of the least square estimates adjusted for covariates for the re-ordered variables is presented in Table 6. The direction of change for the main effects of School and Sex are indicated as positive and negative values.

Table 7 provides a summary of the pre-test and post-test means for the re-ordered variables. Cell means are presented for both schools, experimental and control, and both sexes, male and female.

Table 6. Least square estimates adjusted for covariates: re-ordered* variables for kindergarten

	Variables		
	AAS3**	AAS1	AA TOT
Hyp. 1: School	-8.066	-0.950	-2.141
Hyp. 2: Sex	-2.309	3.284	1.308
Hyp. 3: Interaction	-0.149	-2.768	0.267

*See Chapter III, p. 37, for a discussion on the re-ordering procedures.

**Throughout the presentation of the results of this study, academic achievement sub-tests will be represented in this form, i.e., AAS3 denotes academic achievement sub-test 3, AAS1 denotes academic achievement sub-test 1. Similarly, AA TOT will be used to denote academic achievement total and M.AB. to denote mental ability (I.Q.).

Table 7. Cell means for experimental and control schools: re-ordered variables for kindergarten

	Variables					
	AAS3		AAS1		AA TOT	
	Pre	Post	Pre	Post	Pre	Post
Exp. Males	45.409	44.327	52.182	50.921	48.877	48.992
Exp. Females	49.247	47.457	50.263	48.813	51.003	49.133
Cont. Males	52.300	54.721	51.595	54.016	52.201	53.475
Cont. Females	54.486	56.003	46.200	47.524	48.797	49.766

A summary of the results of the univariate analyses of covariance test for School effects (AA TOT) is presented in Table 8.

Table 8. Univariate* analysis of covariance test for school effects: kindergarten academic achievement total

D.F. = 1 and 106			
Variable	Between Mean Square	Univariate F	P Less Than
AA TOT	107.2693	4.5501	.0353

*No mental ability test for kindergarten.

The univariate analysis of covariance test for School effects (AA TOT) was significant (P<.0353) in favor of the control group, thus allowing for the rejection of the null hypothesis of no difference between schools at the kindergarten level.

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA Sub-tests) is presented in Table 9.

Table 9. Multivariate and univariate analysis of covariance tests for school effects: kindergarten academic achievement sub-tests

D.F. = 2 and 104 F - Ratio = 16.3254 P<0.0001					
Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS3*	1587.0239	31.6761	.0001	31.6761	.0001
AAS1	3.9949	0.0506	.8226	0.9806	.3244
	D.F. for Hypothesis = 1		D.F. for Error = 105		

*Academic Achievement Sub-test 3.

Multivariate and step-down alpha level required for rejection = .05.
Univariate alpha level required for rejection = .025.

The multivariate main effect for Schools (AA Sub-tests) was statistically significant (P<.0001) in favor of the control school. Of interest is the fact that AAS3, Letters and Sounds, accounted almost entirely (P<.0001) for the significant difference noted between schools.

A summary of the results of the univariate analysis of covariance test for Sex effects (AA TOT) is presented in Table 10.

Table 10. Univariate analysis of covariance test for Sex effects: kindergarten academic achievement total

D.F. = 1 and 106

Variable	Between Mean Square	Univariate F	P Less Than
AA TOT	48.0541	2.0383	.1564

Univariate alpha level required for rejection = .05.

The univariate main effect of Sex was not statistically significant (P<.1564).

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA Sub-tests) is presented in Table 11. The multivariate main effect for sex was statistically significant (P<.0290). Of interest, however, is the fact that neither AAS3 or AAS1 are significant by themselves when considered in the univariate analysis. This indicates that the two sub-tests do not contribute significantly, when taken individually, to the overall significant difference for sex effects. However, considered together, the two sub-tests account for a significant amount of the variability between sexes at the kindergarten level. Of note also is the fact that AAS1, the Environment, indicated a greater increase by the males, while AAS3, Letters and Sounds, showed superior performance by the females.

Table 11. Multivariate and univariate analysis of covariance tests for Sex effects: kindergarten academic achievement sub-tests

D.F. = 2 and 104 F - Ratio = 3.6674
P<0.0290

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS3	134.4902	2.6844	.1044	2.6844	.1044
AAS1	235.0893	2.9752	.0875	4.5595	.0351

D.F. for Hypothesis = 1 D.F. for Error = 105

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

A summary of the results of the univariate analysis of covariance test for School x Sex interaction (AA TOT) is presented in Table 12.

The interaction of School x Sex (AA TOT) was not statistically significant (P<.8891).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex Interaction (AA Sub-test) is presented in Table 13.

The interaction of School x Sex (AA Sub-tests was not statistically significant (P<.7228).

Table 12. Univariate analysis of covariance test for School x Sex interaction effects: kindergarten academic achievement total

D.F. = 1 and 106			
Variable	Between Mean Square	Univariate F	P Less Than
AA TOT	0.4613	0.0196	.8891

Univariate alpha level required for rejection = .05.

Table 13. Multivariate and univariate analysis of covariance tests for School x Sex interaction: kindergarten academic achievement sub-tests

D.F. = 2 and 104			F - Ratio = 0.3257		
Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS3	0.1469	0.0029	.9570	0.0029	.9570
AAS1	50.4483	0.6384	.4261	0.6484	.4226
	D.F. for Hypothesis = 1		D.F. for Error = 105		

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

Grade One

A summary of the least square estimates adjusted for covariates for the re-ordered variables is presented in Table 14. The direction of change for the main effects of School and Sex are indicated as positive and negative values.

Table 14. Least square estimates adjusted for covariates: re-ordered variables for grade 1

	Variables					
	AAS1	AAS4	AAS5	AAS6	AA TOT	M.AB.
Hyp. 1: School	-5.203	-3.494	-7.000	-2.425	-3.073	-3.269
Hyp. 2: Sex	-0.523	-0.061	-0.374	-3.351	-0.996	0.487
Hyp. 3: Interaction	6.119	-7.483	-3.338	0.381	-0.814	-0.529

Table 15 provides a summary of the pre-test and post-test means for the re-ordered variables. Cell means are presented for both schools, experimental and control, and both sexes, male and female.

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA TOT and M.AB.) is presented in Table 16.

The multivariate main effect for Schools was statistically significant (P<.0002) in favor of the control school. Thus, the null hypothesis of no difference between schools was rejected at the Grade 1 level. It is noted that AA TOT alone (P<.0002) is significant in the univariate and step-down analyses, thus indicating that the greater proportion of the overall variability between schools is accounted for by AA TOT.

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA Sub-tests) is presented in Table 17.

The multivariate main effect for Schools (AA Sub-tests) was statistically significant (P<.0001) in favor of the control school. Thus, the null hypothesis of no difference between schools was rejected at the

Table 15. Cell means for experimental and control schools: re-ordered variables for grade 1

	Variables					
	AAS1		AAS4		AAS5	
	Pre	Post	Pre	Post	Pre	Post
Exp. Males	51.068	50.224	50.532	47.108	47.114	45.530
Exp. Females	49.116	47.568	53.520	52.216	48.412	49.152
Cont. Males	54.482	49.822	49.389	52.159	51.370	51.937
Cont. Females	47.173	51.600	46.940	47.943	53.650	52.620
	AAS6		AA TOT		M.AB.	
	Pre	Post	Pre	Post	Pre	Post
Exp. Males	52.681	45.130	49.757	48.137	43.000	39.054
Exp. Females	55.496	51.132	51.531	50.669	43.040	39.840
Cont. Males	44.474	50.815	49.476	50.508	37.963	40.518
Cont. Females	47.107	72.056	49.495	51.282	38.900	40.133

Table 16. Multivariate and univariate analysis of covariance tests for school effects: grade 1 academic achievement total and mental ability

D.F. = 2 and 112 F - Ratio = 9.3328
P<.0002

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	265.1438	15.7939	.0002	15.7939	.0002
M.AB.	265.6993	4.6708	.0328	2,6423	.1069

D.F. for Hypothesis = 1 D.F. for Error = 113

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

Table 17. Multivariate and univariate analysis of covariance tests for school effects: grade 1 academic achievement sub-tests

D.F. = 4 and 108 F - Ratio = 9.0915
P<.0001

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS1	505.1982	9.3047	.0029	9.3047	.0029
AAS4	280.7770	3.0501	.0835	5.3397	.0028
AAS5	1016.3902	11.3220	.0011	9.8161	.0023
AAS6	738.7188	0.9811	.3241	8.5389	.0043

D.F. for Hypothesis = 1 D.F. for Error = 111

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

Grade 1 level. Of interest is the fact that AAS1 and AAS5 appeared significant in both the univariate and step-down analyses and are thus considered to be the greatest contributors to the overall rejection of the School hypothesis. It is also interesting to note that the step-down value for AAS6 (P<.0043) is also significant. This means that after taking out the variance due to academic achievement sub-tests one, four and five (AAS1, AAS4, AAS5), academic achievement sub-test six (AAS6) is still significant when considered together with the other three sub-tests. Similar findings are in evidence for the fourth re-ordered variable, AAS4: Spelling. However, the reader will note the criteria for significance as stated earlier (i.e., a sub-test must be significant, or extremely close to significant in the univariate analysis before consideration would be given to the step-down values). Thus, in this analysis, the only variables considered significant are AAS1: Word Reading, and AAS5: Word Study Skills.

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA TOT and M.AB.) is presented in Table 18.

Table 18. Multivariate and univariate analysis of covariance tests for Sex effects: grade 1 academic achievement total and mental ability

D.F. = 2 and 112 F - Ratio = 0.9846
P<.3769

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	29.3502	1.7483	.1888	1.7483	.1888
M.AB.	6.6926	0.1176	.7323	0.2327	.6305

D.F. for Hypothesis = 1 D.F. for Error = 113

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The main effect of Sex (AA TOT and M.AB.) was not significant (P<.3769).

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA Sub-tests) is presented in Table 19.

The main effect of Sex (AA Sub-tests) was not significant (P<.7748).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA TOT and M.AB.) is presented in Table 20.

Table 19. Multivariate and univariate analysis of covariance tests for Sex effects: grade 1 academic achievement sub-tests

D.F. = 4 and 108 F - Ratio = 0.4464
P<.7748

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS1	5.2913	0.0975	.7555	0.0975	.7555
AAS4	0.6108	0.0066	.9353	0.0217	.8833
AAS5	4.5098	0.0502	.8231	0.0613	.8050
AAS6	5.3125	0.7183	.3986	1.6061	.2078

D.F. for Hypothesis = 1 D.F. for Error = 111

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

Table 20. Multivariate and univariate analysis of covariance tests for School x Sex interaction: grade 1 academic achievement total and mental ability

D.F. = 2 and 112 F - Ratio = 0.1487
P<0.8620

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	4.7496	0.2829	.5949	0.2829	.5959
M.AB.	2.0010	0.0352	.8516	0.0170	.8966

D.F. for Hypothesis = 1 D.F. for Error = 113

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The interaction of School x Sex (AA TOT and M.AB.) was not statistically significant (P<.8620).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA Sub-tests) is presented in Table 21.

Table 21. Multivariate and univariate analysis of covariance tests for School x Sex interaction: grade 1 academic achievement sub-tests

D.F. = 4 and 108 F - Ratio = 2.1298
P<.0821

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS1	263.0249	4.8444	.0299	4.8444	.0299
AAS4	393.3775	4.2733	.0411	2.5994	.1098
AAS5	78.2754	0.8719	.3525	0.0001	.9921
AAS6	443.2656	0.7577	.3860	1.0683	.3037

D.F. for Hypothesis = 1 D.F. for Error = 111

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

The overall interaction of School x Sex (AA Sub-tests) was not statistically significant (P<.0821).

Grade Two

A summary of the least square estimates adjusted for covariates for the re-ordered variables, is presented in Table 22. The direction of change for the main effects of School and Sex are indicated as positive and negative values.

Table 22. Least square estimates adjusted for covariates: re-ordered variables for grade 2

	Variables		
	AAS4	AA TOT	M.AB.
Hyp. 1: School	-1.017	-0.115	-1.439
Hyp. 2: Sex	0.835	0.673	0.394
Hyp. 3: Interaction	2.701	2.501	4.713

Table 23 provides a summary of the pre-test and post-test means for the re-ordered variables. Cell means are presented for both schools, experimental and control, and both sexes, male and female.

Table 23. Cell means for experimental and control schools: re-ordered variables for grade 2

	Variables					
	AAS4		AA TOT		M.AB.	
	Pre	Post	Pre	Post	Pre	Post
Exp. Males	49.425	50.094	48.457	49.682	41.938	49.000
Exp. Females	46.019	45.323	47.752	47.724	46.667	54.381
Cont. Males	52.372	51.996	52.399	51.663	41.240	52.920
Cont. Females	51.127	51.566	50.395	50.376	39.133	48.267

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA TOT and M.AB.) is presented in Table 24.

Table 24. Multivariate and univariate analysis of covariance tests for school effects: grade 2 academic achievement total and mental ability

D.F. = 2 and 85 F - Ratio = 0.3180
P<.7285

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	1.3233	0.1438	.7055	0.1438	.7055
M.AB.	25.0823	0.6356	.4275	0.4930	.4846

D.F. for Hypothesis = 1 D.F. for Error = 86

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The main effect of School (AA TOT and M.AB.) was not significant (P<.7285).

A summary of the results of the univariate test for School effects (AA Sub-tests) is presented in Table 25.

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA TOT and M.AB.) is presented in Table 26.

The main effect of Sex was not statistically significant (P<.7357).

A summary of the results of the univariate test for Sex effects (AA Sub-tests) is presented in Table 27.

The univariate main effect of Sex (AA Sub-tests) was not statistically significant (P<.6773).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA TOT and M.AB.) is presented in Table 28.

Table 25. Univariate* analysis of covariance test for school effects: grade 2 academic achievement sub-tests

D.F. = 1 and 87

Variable	Between Mean Square	Univariate F	P Less Than

Univariate alpha level required for rejection = .05.

*Analysis of the original multivariate and univariate tests of the mean vectors for School (AA Sub-tests) indicated that it was not necessary to re-order the sub-tests. Only variable AAS4 had a possibility of reaching significance according to the criteria set by the author for re-ordering variables appearing in the original multivariate analyses (P<.10). Thus, variable AAS4 was re-analyzed in a univariate analysis. The main effect of School was not significant (P<.3957).

Table 26. Multivariate and univariate analysis of covariance test for Sex effects: grade 2 academic achievement total and mental ability

D.F. = 2 and 85 F - Ratio = 0.3082
P<.7357

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	3.9776	0.4323	.5127	0.4323	.5127
M.AB.	16.7310	0.4240	.5167	0.1382	.6656

D.F. for Hypothesis = 1 D.F. for Error = 86

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

Table 27. Univariate analysis of covariance test for Sex effects: grade 2 AA sub-tests

D.F. = 1 and 87			
Variable	Between Mean Square	Univariate F	P Less Than
AAS4	7.1529	0.1744	.6773

Univariate alpha level required for rejection = .05.

Table 28. Multivariate and univariate analysis of covariance test for School x Sex interaction: grade 2 AA TOT and M.AB.

D.F. = 2 and 85 F - Ratio = 5.1294
P<.0079

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	32.7940	3.5638	.0625	3.5638	.0625
M.AB.	116.4265	2.9505	.0895	6.4683	.0128

D.F. for Hypothesis = 1 D.F. for Error = 86

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The multivariate main effect for School x Sex interaction was statistically significant (P<.0079). Of interest, however, is the fact that neither academic achievement total nor mental ability were significant when taken by themselves, i.e., in the univariate analyses. Thus, graphs have been constructed for both variables, indicating the School x Sex interaction, since both variables appear to account for a large proportion of the overall multivariate interaction. Figures 1 and 2 present a summary of the School x Sex interaction for grade two males and females.

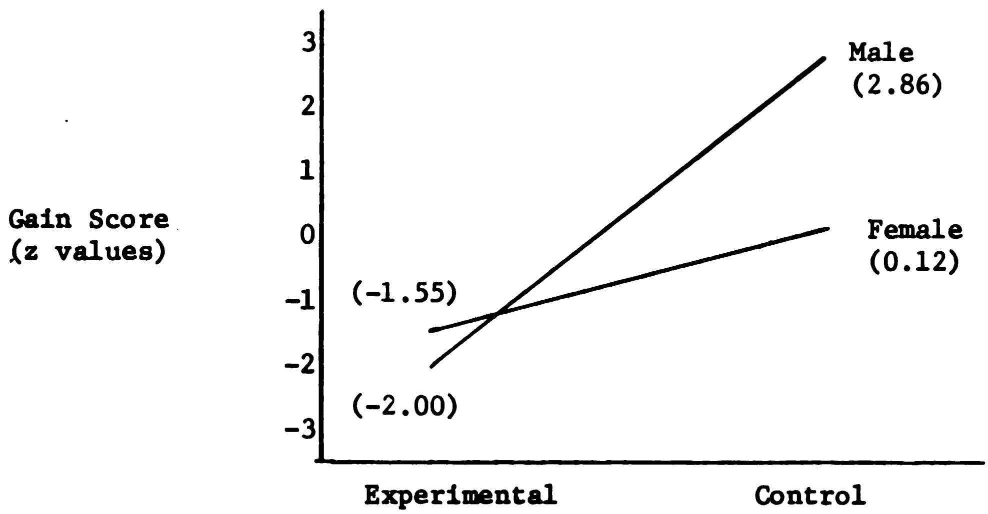

Figure 1. School x Sex interaction for grade 2 subjects: mental ability.

The interaction plotted in Figure 1 indicates that the physical education program very possibly had a differential effect on the two sexes, with respect to mental ability scores. Further inspection indicates that within the experimental group, slightly larger gains were registered by the females. The opposite situation is seen to exist within the control school where the improvement shown by the males is much larger than that exhibited by the females.

The interaction plotted in Figure 2 once again indicates that the physical education program very possibly had a differential effect on the two sexes, with respect to gains in total academic achievement. Inspection of Figure 2 suggests that within the experimental setting, the males achieved to a greater extent than the females, whereas in the control school, the males gained less than did the females. These results are in opposition to those presented in Figure 1 for mental ability.

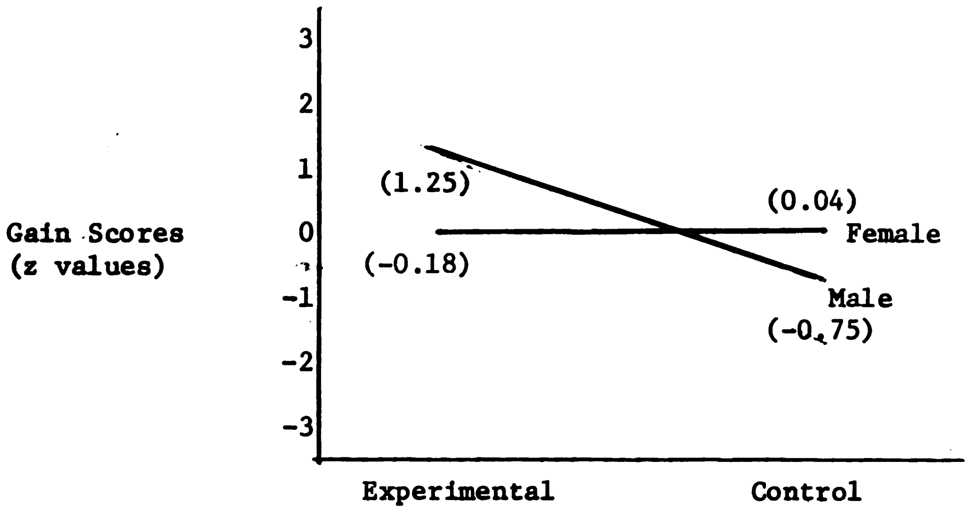

Figure 2. School x Sex interaction for grade 2 subjects: academic achievement total.

A summary of the results of the univariate covariance test for the School x Sex interaction (AA Sub-tests) is presented in Table 29.

Table 29. Univariate analysis of covariance test for School x Sex interaction: grade 2 AA sub-tests

D.F. = 1 and 87			
Variable	Between Mean Square	Univariate F	P Less Than
AAS4	39.6627	0.9670	0.382

Univariate alpha level required for rejection = .05.

The interaction of School x Sex (AA Sub-tests) was not statistically significant (P<.3282).

Grade Three

A summary of the least square estimates adjusted for covariates for the re-ordered variables, is presented in Table 30. The direction of change for the main effects of School and Sex are indicated as positive and negative values.

Table 30. Least square estimates adjusted for covariates: re-ordered variables for grade 3

	Variables					
	AAS8	AAS6	AAS2	AAS3	AA TOT	M.AB.
Hyp. 1: School	1.456	-1.428	3.010	1.573	-0.974	0.918
Hyp. 2: Sex	2.494	-0.555	-1.816	2.791	-0.806	-0.319
Hyp. 3: Interaction	3.442	1.254	-0.789	0.839	0.982	0.973

Table 31 provides a summary of the pre-test and post-test means for the re-ordered variables. Cell means are presented for both schools, experimental and control, and both sexes, male and female.

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA TOT and M.AB.) is presented in Table 32.

The main effect of School (AA TOT and M.AB.) was not statistically significant (P<.3133).

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA Sub-tests) is presented in Table 33.

Table 31. Cell means for re-ordered variables for experimental and control schools: grade 3

	AAS8 Pre	AAS8 Post	AAS6 Pre	AAS6 Post	AAS2 Pre	AAS2 Post
Exp. Males	50.870	50.737	45.663	46.837	46.411	47.307
Exp. Females	52.700	49.662	51.114	49.948	49.338	52.119
Cont. Males	47.776	48.138	49.046	49.058	49.200	47.292
Cont. Females	49.096	51.416	54.764	54.440	55.308	53.960

	AAS3 Pre	AAS3 Post	AA TOT Pre	AA TOT Post	M.AB. Pre	M.AB. Post
Exp. Males	52.944	51.937	49.006	48.381	48.852	58.444
Exp. Females	50.585	49.000	51.895	50.789	49.857	59.524
Cont. Males	48.642	49.623	47.720	48.059	49.000	56.846
Cont. Females	47.728	49.004	51.854	53.105	54.000	61.600

Table 32. Multivariate and univariate analysis of covariance tests for school effects: grade 3 AA TOT and M.AB.

D.F. = 2 and 92 F - Ratio = 1.1754
P<.3133

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	23.0930	1.3560	.2473	1.3560	.2473
M.AB.	21.0873	0.7130	.4007	0.9948	.3212

D.F. for Hypothesis = 1 D.F. for Error = 93

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

Table 33. Multivariate and univariate analysis of covariance tests for school effects: grade 3 AA sub-tests

	D.F. = 4 and 88	P<.1042	F - Ratio = 1.9821		
Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS8	55.8863	1.8039	.1826	1.8039	.1826
AAS6	38.0299	0.9056	.3439	1.1124	.2944
AAS2	158.7283	4.7985	.0311	4.8135	.0309
AAS3	58.4593	0.7595	.3858	0.1480	.7014
	D.F. for Hypothesis = 1		D.F. for Error = 91		

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

The main effect of School (AA Sub-tests) was not statistically significant (P<.1042).

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA TOT and M.AB.) is presented in Table 34.

The main effect of Sex (AA TOT and M.AB.) was not significant (P<.6217).

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA Sub-tests) is presented in Table 35.

The main effect of Sex (AA Sub-tests) was significant (P<.0376). This indicates that even though the sexes did not differ significantly in AA Total (Table 34), a statistical difference was noted in the sub-tests. Of interest was the fact that no single sub-test appeared to account for a significant amount of the variation between sexes. Two

Table 34. Multivariate and univariate analysis of covariance test for Sex effects: grade 3 AA TOT and M.AB.

D.F. = 2 and 92 F - Ratio = 0.4778
P<0.6217

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	15.9447	0.9363	.3358	0.9363	.3358
M.AB.	2.6726	0.0904	.7644	0.0290	.8652

D.F. for Hypothesis = 1 D.F. for Error = 93

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

Table 35. Multivariate and univariate analysis of covariance test for Sex effects: grade 3 AA sub-tests

D.F. = 4 and 88 F - Ratio = 2.6660
P<.0376

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS8	126.6169	4.0869	.0462	4.0869	.0462
AAS6	7.1969	0.1714	.6799	0.3294	.5675
AAS2	69.6305	2.1050	.1503	4.4829	.0371
AAS3	165.3471	2.1483	.1462	1.5674	.2140

D.F. for Hypothesis = 1 D.F. for Error = 91

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

sub-tests (AAS8, AAS2), however, when taken togehter with AAS6 and AAS3, appeared to account for a large proportion of the variability. It is interesting also that AAS8 favored the males while AAS2 favored the females.

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA TOT and M.AB.) is presented in Table 36.

Table 36. Multivariate and univariate analysis of covariance test for School x Sex interaction: grade 3 AA TOT and M.AB.

D.F. = 2 and 92 F - Ratio = 0.2359
P<.7904

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	5.8493	0.3435	.5593	0.3435	.5593
M.AB.	5.7460	0.1943	.6604	0.1315	.7177

D.F. for Hypothesis = 1 D.F. for Error = 93

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The interaction of School x Sex (AA TOT and M.AB.) was not statistically significant (P<.7904).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA Sub-tests) is presented in Table 37.

The interaction of School x Sex (AA Sub-tests) was not statistically significant (P<.5000).

Table 37. Multivariate and univariate analysis of covariance test for School x Sex interaction: grade 3 AA sub-tests

D.F. = 4 and 88 F - Ratio = 0.8458
P<.5000

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS8	70.4614	2.2743	.1350	2.2743	.1350
AAS6	9.3513	0.2227	.6382	0.1139	.7366
AAS2	3.7033	0.1120	.7388	1.0375	.3112
AAS3	4.1897	0.0544	.8161	0.0163	.8987

D.F. for Hypothesis = 1 D.F. for Error = 91

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

Grade Four

A summary of the least square estimates adjusted for covariates, for the re-ordered variables, is presented in Table 38. The direction of change for the main effects of School and Sex are indicated as positive and negative values.

Table 39 provides a summary of the pre-test and post-test means for the re-ordered variables. Cell means are presented for both schools, experimental and control, and both sexes, male and female.

A summary of the results of the multivariate and univariate tests of the mean vectors for School (AA TOT and M.AB.) is presented in Table 40.

The main effect of School was statistically significant (P<.001), in favor of the experimental school. Thus, the null hypothesis of no difference between schools at the Grade 4 level is rejected.

Table 38. Least square estimates adjusted for covariates: re-ordered variables for grade 4

	Variables					
	AAS1	AAS7	AAS5	AAS2	AA TOT	M.AB.
Hyp. 1: School	1.732	1.666	1.872	1.875	4.205	6.709
Hyp. 2: Sex	1.902	1.830	2.056	2.059	0.050	-0.867
Hyp. 3: Interaction	3.079	2.963	3.328	3.330	-0.481	1.806

Table 39. Cell means for experimental and control schools: re-ordered variables for grade 4

	Variables					
	AAS1		AAS7		AAS5	
	Pre	Post	Pre	Post	Pre	Post
Exp. Males	50.805	53.671	55.210	52.876	50.552	52.129
Exp. Females	45.513	50.647	48.533	52.507	43.120	51.367
Cont. Males	50.953	46.827	49.700	50.260	45.507	45.860
Cont. Females	51.815	48.030	45.880	44.895	50.490	49.855

	AAS2		AA TOT		M.AB.	
	Pre	Post	Pre	Post	Pre	Post
Exp. Males	51.324	54.838	51.613	53.725	42.428	51.667
Exp. Females	48.473	48.193	49.029	50.974	34.133	45.267
Cont. Males	50.100	46.973	49.367	47.529	37.067	39.600
Cont. Females	49.680	48.525	49.508	47.211	36.450	41.100

Table 40. Multivariate and univariate analysis of covariance tests for school effects: grade 4 AA TOT and M.AB.

D.F. = 2 and 64 F - Ratio = 13.3151
P<.0001

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	312.2225	21.9972	.0001	21.9972	.0001
M.AB.	763.5895	20.2002	.0001	3.7144	.0584

D.F. for Hypothesis = 1 D.F. for Error = 65

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

It is noted that both AA TOT (P<.0001) and M.AB. (P<.0001) are highly significant in the univariate analyses. However, of particular interest is the fact that mental ability, although individually significant, is not significant (P<.0584) when considered together with academic achievement total. This indicates that after deleting the effect of academic achievement total, the explanatory force of mental ability is diminished to the extent that it is not statistically significant. In other words, in the "package", it is not as great a contributor to the overall significant difference between schools as is academic achievement total.

A summary of the results of the multivariate and univariate tests of the mean vectors for School (AA Sub-tests) is presented in Table 41.

The null hypothesis of no difference between schools (Grade 4) with respect to academic achievement sub-tests was rejected (P<.0238) in favor of the experimental school. The univariate and step-down tests of

Table 41. Multivariate and univariate analysis of covariance tests for school effects: grade 4 AA sub-tests

D.F. = 4 and 60 F - Ratio = 3.0443
P<.0238

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS1	392.2747	9.9383	.0025	9.9383	.0025
AAS7	61.5092	1.6829	.1993	0.6028	.4405
AAS5	264.3686	5.7316	.0197	1.7703	.1883
AAS2	142.5420	3.0807	.0841	0.0011	.9738

D.F. for Hypothesis = 1 D.F. for Error = 63

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

significance indicate a significant difference on Sub-test 1: Word Meaning. This indicates that Sub-test 1 is the greatest contributor to the overall difference noted between schools.

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA TOT and M.AB.) is presented in Table 42.

The main effect for Sex (AA TOT and M.AB.) was not significant (P<.7712).

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA Sub-tests) is presented in Table 43.

The main effect of Sex (AA Sub-tests) was not significant (P<.0889).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA TOT and M.AB.) is presented in Table 44.

Table 42. Multivariate and univariate analysis of covariance tests for Sex effects: grade 4 AA TOT and M.AB.

D.F. = 2 and 64 F - Ratio = .2609
P<.7712

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	0.0369	0.0026	.9595	0.0026	.9595
M.AB.	12.3692	0.3272	.5693	0.5193	.4738

D.F. for Hypothesis = 1 D.F. for Error = 65

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

Table 43. Multivariate and univariate analysis of covariance tests for Sex effects: grade 4 AA sub-tests

D.F. = 4 and 60 F - Ratio = 2.1238
P<.0889

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS1	45.2994	1.1477	.2882	1.1477	.2882
AAS7	58.1047	1.5898	.2121	1.2021	.2772
AAS5	29.1878	0.6328	.4294	2.1670	.1462
AAS2	168.5579	3.6430	.0609	3.7264	.0583

D.F. for Hypothesis = 1 D.F. for Error = 63

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

Table 44. Multivariate and univariate analysis of covariance tests for School x Sex interaction: grade 4 AA TOT and M.AB.

D.F. = 2 and 64 F - Ratio = 0.4388
P<.6468

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	0.9776	0.0689	.7939	0.0689	.7939
M.AB.	13.7266	0.3631	.5489	0.8089	.3719

D.F. for Hypothesis = 1 D.F. for Error = 65

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The interaction of School x Sex (AA TOT and M.AB.) was not statistically significant (P<.6468).

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA Sub-tests) is presented in Table 45.

The interaction of School x Sex (AA Sub-tests) was not significant (P<.0579). However, AAS7 was considered significant in that the univariate value (P<.0202) was close to reaching significance. Further evidence is forthcoming upon an examination of the step-down value (P<.0181).

The interaction plotted in Figure 3 indicates that the physical education program very possibly had a differential effect on the two sexes, with respect to scores on Academic Achievement Sub-test 7. Further inspection indicates that within the experimental group, much larger gains were registered by the females. The opposite situation is seen to

Table 45. Multivariate and univariate analysis of covariance tests for School x Sex interaction: grade 4 AA sub-tests

D.F. = 4 and 60 F - Ratio = 2.4241
P<.0579

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS1	2.7941	0.0708	.7911	0.0708	.7911
AAS7	207.8227	5.6862	.0202	5.9030	.0181
AAS5	3.4522	0.0748	.7854	0.9289	.3387
AAS2	136.7116	2.9547	.0906	2.6117	.1114

D.F. for Hypothesis = 1 D.F. for Error = 63

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0125.

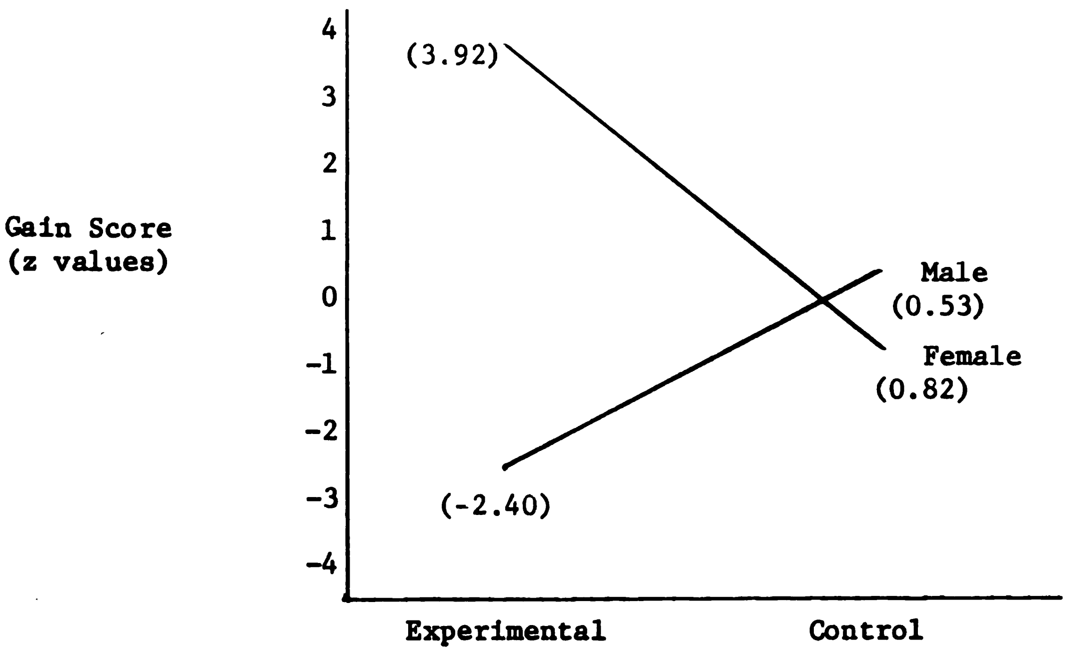

Figure 3. School x Sex interaction for grade 4 subjects: Academic Achievement Sub-test 7.

exist, though not as extreme, within the control school, where the improvement shown by the males is slightly larger than that exhibited by the females.

Grade Five

A summary of the least square estimates adjusted for covariates for the re-ordered variables is presented in Table 46. The direction of change for the main effects of School and Sex are indicated as positive and negative values.

Table 46. Least square estimates adjusted for covariates: re-ordered variables for grade 5

	Variables			
	AAS2	AAS9	AAS3	AAS5
Hyp. 1: School	1.669	2.913	-1.155	-4.272
Hyp. 2: Sex	-2.954	2.515	0.103	-2.135
Hyp. 3: Interaction	3.109	1.418	3.875	-0.109
	AAS6	AAS8	AA TOT	M.AB.
Hyp. 1: School	0.354	-2.675	-0.526	-0.972
Hyp. 2: Sex	2.005	-2.073	-0.163	-1.417
Hyp. 3: Interaction	-2.021	1.481	0.945	4.555

Table 47 provides a summary of the pre-test and post-test means for the re-ordered variables. Cell means are presented for both schools, experimental and control, and both sexes, males and females.

Table 47. Cell means for experimental and control treatment groups: re-ordered variables for grade 5

	AAS2		AAS9		AAS3		AAS5	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Exp. Males	50.685	50.692	50.754	52.919	47.258	48.246	49.396	47.258
Exp. Females	48.810	50.661	49.926	49.174	50.829	49.684	52.032	49.842
Cont. Males	48.839	45.550	48.433	47.788	47.194	47.361	48.439	50.594
Cont. Females	51.960	52.805	50.535	49.475	54.780	55.145	49.030	53.255
	AAS6		AAS8		AA TOT.		M.AB.	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Exp. Males	51.862	52.307	51.492	49.150	50.034	50.008	51.462	56.192
Exp. Females	49.555	49.168	48.435	48.732	50.090	49.706	49.484	52.129
Cont. Males	49.522	50.972	49.244	49.267	48.540	48.683	47.333	52.278
Cont. Females	48.690	47.420	51.175	53.720	51.130	51.628	50.550	56.800

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA TOT and M.AB.) is presented in Table 48.

Table 48. Multivariate and univariate analysis of covariance tests for school effects: grade 5 AA TOT and M.AB.

D.F. = 2 and 88 F - Ratio = 0.5910
P<0.5560

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	6.9887	0.7312	.3948	0.7312	.3948
M.AB.	30.2392	0.7463	.3900	.4554	.5016

D.F. for Hypothesis = 1 D.F. for Error = 89

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The main effect of School (AA TOT and M.AB.) was not statistically significant (P<.5560).

A summary of the results of the multivariate and univariate tests of the mean vectors for Schools (AA Sub-tests) is presented in Table 49.

The main effect of Schools (AA Sub-tests) was significant (P<.0005). The following sub-tests were considered significant after referring to the univariate F values:

a) AAS9: Science (P<.0091)*

*Although the required value for significance was .0083, i.e., $\frac{\alpha}{n}$, where n = the number of sub-tests and α = .05, it was considered realistic to include AAS9 (P<.0091) as significant.

Table 49. Multivariate and univariate analysis of covariance tests for school effects: grade 5 AA sub-tests

D.F. = 6 and 80 F - Ratio = 4.6387
P<.0005

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS2	53.2863	3.3650	.0701	3.3650	.0701
AAS9	162.9940	7.1451	.0091	4.6067	.0348
AAS3	34.2647	1.1705	.2824	3.9526	.0501
AAS5	367.2261	6.6768	.0115	5.8167	.0182
AAS6	3.1207	0.0755	.7842	0.1946	.6603
AAS8	148.4657	4.7965	.0313	7.4357	.0079

D.F. for Hypothesis = 1 D.F. for Error = 85

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0083.

b) AAS5: Arithmetic Comprehension (P<.0115)*

Consideration of the step-down F values necessitated the inclusion of AAS8: Social Studies (P<.0079), together with AAS9 and AAS5, in the list of sub-tests contributing significantly to the difference noted between schools in academic achievement sub-tests.

Of particular interest is the fact that the sub-tests noted as significant did not favor the same school. Whereas AAS9 favored the experimental school, AAS5 and AAS8 were found to be in favor of the control school.

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*Included as significant for the same reason as cited above for the inclusion of AAS9.

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA TOT and M.AB.) is presented in Table 50.

Table 50. Multivariate and univariate analysis of covariance tests for Sex effects: grade 5 AA TOT and M.AB.

D.F. = 2 and 88 F - Ratio = 1.0825
P<.3433

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	0.1105	0.0116	.9147	0.0116	.9147
M.AB.	80.4145	1.9847	.1624	2.1533	.1459

D.F. for Hypothesis = 1 D.F. for Error = 89

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

The main effect of Sex (AA TOT and M.AB.) was not statistically significant (P<.3433).

A summary of the results of the multivariate and univariate tests of the mean vectors for Sex (AA Sub-tests) is presented in Table 51.

The main effect for Sex (AA Sub-tests) was statistically significant (P<.0003). The following sub-tests were considered significant after referring to the univariate F values:

a) AAS2: Paragraph Meaning (P<.0049)

b) AAS9: Science (P<.0179)*

*It was again considered realistic to include AAS9 as significant in that the univariate F value fell just short of significance. Further evidence for accepting AAS9 as significant was provided by an inspection of the step-down F value (P<.0013).

Table 51. Multivariate and univariate analysis of covariance tests for Sex effects: grade 5 AA sub-tests

D.F. = 6 and 80 F - Ratio = 4.8582
P<.0003

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS2	132.3122	8.3556	.0049	8.3556	.0049
AAS9	133.1454	5.8366	.0179	11.1988	.0013
AAS3	4.4583	0.1523	.6974	0.5486	.4610
AAS5	86.9934	1.5817	.2120	0.4310	.5134
AAS6	61.5680	1.4898	.2257	4.3474	.0403
AAS8	70.1357	2.2659	.1360	2.2440	.1381

D.F. for Hypothesis = 1 D.F. for Error = 85

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0083.

Analysis of the step-down F values did not provide additional significant sub-tests.

Of particular interest was the fact that AAS2 was significant in favor of the females while AAS9 was in favor of the males.

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA TOT and M.AB.) is presented in Table 52.

The interaction of School x Sex (AA TOT and M.AB.) was not statistically significant (P<.2330).

Table 52. Multivariate and univariate analysis of covariance tests for School x Sex interaction: grade 5 AA TOT and M.AB.

D.F. = 2 and 88 F - Ratio = 1.4813
P<0.2330

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AA TOT	5.0303	0.5263	.4701	0.5263	.4701
M.AB.	116.8763	2.8846	.0930	2.4279	.1228

D.F. for Hypothesis = 1 D.F. for Error = 89

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .025.

A summary of the results of the multivariate and univariate covariance tests for the School x Sex interaction (AA Sub-tests) is presented in Table 53.

The interaction of School x Sex (AA Sub-tests) was not statistically significant (P<.5048).

Table 54 contains a summary of the significant main effects obtained in this study. The reader will note that these main effects are grouped by grade level. It should be remembered that two separate covariance analyses (a. AA TOT, M.AB.; b. AA Sub-tests) were conducted for each hypothesis, at each grade level, and thus, in some cases, different multivariate significance levels are reported for the same main effect, i.e., Grade 1 school effects.

Table 53. Multivariate and univariate analysis of covariance tests for School x Sex interaction: grade 5 AA sub-tests

D.F. = 6 and 80 F - Ratio = 0.8922
P<.5048

Variable	Between Mean Square	Univariate F	P Less Than	Step-Down F	P Less Than
AAS2	51.0994	3.2269	.0760	3.2269	.0760
AAS9	10.6358	0.4662	.4966	0.0122	.9123
AAS3	79.3905	2.7120	.1033	1.2159	.2734
AAS5	0.0624	0.0011	.9733	0.2574	.6133
AAS6	21.5890	0.5224	.4719	0.7809	.3795
AAS8	11.5892	0.3744	.5423	0.0072	.9324

D.F. for Hypothesis = 1 D.F. for Error = 85

Multivariate and step-down alpha levels required for rejection = .05.
Univariate alpha level required for rejection = .0083.

Table 54. Summary of significant main effects and interactions: grades K-5

Grade	Main Effect	Multivariate Signif. Level	Signif. Univariate Variables	Univariate Signif. Level	In Favor of
K	School	None*	AA TOT	P<.0353	Control
K	School	P<.0001	AAS3: Letters and Sounds	P<.0001	Control
K	Sex	P<.0290	None**	-	-
1	School	P<.0002	AA TOT	P<.0002	Control
1	School	P<.0001	AAS1: Word Reading	P<.0029	Control
1	School	P<.0001	AAS5: Word Study Skills	P<.0011	Control
2	School x Sex Interaction	P<.0079	None***	-	Experimental and Control†
3	Sex	P<.0376	None††	-	-
4	School	P<.0001	AA TOT	P<.0001	Experimental
4	School	P<.0001	M.AB.	P<.0001	Experimental
4	School	P<.0238	AAS1: Word Meaning	P<.0025	Experimental
5	School x Sex Interaction	P<.0579	AAS7: Arithmetic Concepts†††	P<.0202	Exp. Females; Control Males
5	School	P<.0005	AAS9: Science	P<.0091	Experimental
5	School	P<.0005	AAS5: Arithmetic Comprehension	P<.0015	Control

Table 54 (cont'd.)

Grade	Main Effect	Multivariate Signif. Level	Signif. Univariate Variables	Univariate Signif. Level	In Favor of
5	School	P<.0005	AAS8: Social Studies[θ]	P<.0015	Control
5	Sex	P<.0003	AAS2: Paragraph Meaning	P<.0049	Females
5	Sex	P<.0003	AAS9: Science[θθ]	P<.0179	Males

[*]Academic Achievement Total was the only variable in this analysis.

[**]Neither of the re-ordered variables, AAS3: Letters and Sounds, or AAS1: The Environment, were individually significant, i.e., taken together in the multivariate analysis, they accounted for the significant multivariate main effect.

[***]Neither of the two variables, AA TOT or M.AB., were individually significant, i.e., taken together in the multivariate analysis, they accounted for the significant multivariate interaction.

[†]Opposite results were obtained in the two School x Sex interactions graphed. See pages 57 and 58.

[††]Of the four re-ordered variables, none was individually significant. Further inspection indicated that AAS8: Arithmetic Concepts, and AAS2: Paragraph Meaning, accounted for a large proportion of the significant multivariate main effect.

[†††]It was considered realistic to include the School x Sex interaction for AAS7: Arithmetic Concepts, as significant in that although the univariate F value fell short of significance (P .0202), the step-down value was highly significant (P<.0181).

[θ]It was considered realistic to include AAS8: Social Studies, as significant in that although the univariate F value fell short of significance (P<.0313), the step-down value was highly significant (P<.0079).

[θθ]It was considered realistic to include AAS9: Science, as significant in that although the univariate F value fell short of significance (P<.0179), the step-down F value was highly significant (P<.0013).

CHAPTER V

DISCUSSION

A discussion of the findings of this study with respect to the results reported in previous investigations is difficult, for a number of reasons. First, the scope of this study, in terms of the number of subjects and grade levels involved, is far greater than has been attempted in the majority of previous investigations. Secondly, previous studies have focused primarily on the effects of specific perceptual-motor programs on various academic parameters. Thus, the outcome of these studies is specific to these experimental programs, each with its own stated objectives, and thus are not easily related to the outcomes of this study, which attempts to evaluate the effects of a regular physical education program on normally functioning subjects. Thirdly, most of the perceptual-motor programs have been employed in an attempt to investigate the effects of such programs on reading achievement alone, rather than total academic achievement. Thus, it is within the above limitations that comparisons are drawn between the results of prior investigations and the present study.

A number of conditions existed which must be recognized before the results at individual grade levels are discussed. One of these conditions was the completeness of the program which was followed by the subjects in the experimental group. Although the program was fully formulated (objectives, grade sequences, unit plans and so on) specific lesson plans were not fully developed for all grade levels. Therefore, it is very difficult to evaluate the extent to which the guidelines of the physical education program were actually adhered. Another consideration, applicable at all six grade levels, is the possibility that a condition of "latent learning" may exist. In other words, it may take a period of two to three years, or longer, for the effects of the program to be fully identified.

In the lower elementary grade levels, kindergarten and grade one, significant school effects were noted, all in favor of the control school. More specifically, in kindergarten, the control subjects exhibited significantly greater gains in total academic achievement as well as in one sub-test, Sounds and Letters. In grade one, greater increases were registered by the control subjects with respect to total academic achievement. Sub-test one, Word Reading, and sub-test five, Word Study Skills, also indicated significant gains in favor of the control school. No significant school effects were noted between experimental and control subjects in grade two.

The results of the present investigation thus agree with those obtained by Brown (1968) and Rosen (1966), the former working with grade one subjects, the latter with pupils in grade two. Whereas Brown found greater gains in reading achievement by controls, Rosen noted greater increases in "idea comprehension", a selected measure of reading ability, by his control group. In fact, Rosen indicated that, based on his own study, additional time devoted to reading instruction was more important for reading achievement than time devoted to the types of perceptual training used in his study.

The results obtained in the present study are thus in contradiction with those presented by Painter (1966), McCormick (1968), Boger (1952), and Lewis (1968), all of whom obtained significant increases in academic functioning as a result of perceptual-motor training. Falik (1969), Jacobs (1968a), Jacobs (1968b), O'Donnell and Eisenson (1969) and Robbins (1967) noted no significant differences between experimentals and controls following perceptual-motor training programs introduced at the grade levels under consideration (K, 1, 2). As noted earlier, however, direct comparisons between the present study and those noted above are difficult, in that varying emphases were placed on perceptual-motor activities.

A possible explanation for the highly significant school effect in favor of the control school at the kindergarten level is the differing emphases of the two schools at this level. Whereas the control school is markedly structured and "academic-oriented", the experimental school adopted an approach stressing the "socialization" aspect to a much greater extent in its approach to teaching at the kindergarten level. Thus, it is possible that the highly academic approach apparent in the control school accounted for the differential increase in academic achievement. Similarly, the possibility exists that a carry-over of the results of this academic approach to learning at the kindergarten level is experienced at the first grade level, thus helping to account for the highly significant school effects once again registered in favor of the control subjects. Nevertheless, the results presented for school effects at the kindergarten and first grade levels indicate that the objective-centered sequential program of physical education appeared to do little or nothing to counteract the academic approach of the control school. One might continue with this reasoning, in reference to the non-significant school main effects at the grade two level, suggesting that the waning influence of the highly academic program at the kindergarten level was finally counterbalanced by the positive effects of the physical education program at the experimental school in grade two. To this writer, however, the foregoing explanation appears to be highly speculative and the non-significant results at the grade two level will not be subjected to further interpretation.

Nevertheless, it is interesting to note that after reaching equality with respect to school main effects at the grade two level, the trend begins to swing toward the experimental school. Although non-significant multivariate values are evident in both analyses (AA TOT, M.AB., and AA Sub-tests) at the grade three level, the only variable which approaches significance is in favor of the experimental school. This variable, AAS2: Paragraph Meaning, approaches significance at the univariate level ($P<.0311$) and is in fact significant in the step-down analysis ($P<.0309$). Furthermore, four of the six academic variables, though not significant, favor the experimental school.

At the grade four level, the shift with respect to the main effect of schools is complete. At this level, the experimental school exhibits significant superiority in terms of academic increases. Both total academic achievement and mental ability, as well as one sub-test, AAS1: Word Reading, are statistically significant. These results concur with those presented by Ismail (1967), in the only investigation reported in the literature similar in nature to the present study. While Ismail obtained significance in favor of the experimental group, in total academic achievement, non-significant results are reported with respect to mental ability. It is interesting to note that in the present investigation, both total academic achievement and mental ability were highly significant in favor of the experimental school at the fourth grade level. No reasons are readily apparent for the shift in experimental effects, first from superiority of the control school to apparent non-significance, and finally to superiority, in terms of academic gains, to the experimental school. An obvious interpretation is to suggest that the physical education program had a beneficial effect, with respect to academic achievement, upon the upper elementary aged pupils, while exhibiting a negative effect on those enrolled in the lower grade levels. However, this conclusion is rendered untenable upon consulting the results presented for the grade five subjects. Two of three significant sub-tests indicate greater gains by the control school, thus contradicting the results obtained by Ismail as well as those presented in this study for grade four students.

Also of interest is the fact that the three significant sub-tests noted at the grade five level are completely different than those noted as significantly different at earlier grade levels. Whereas previous significant differences involved primarily language arts variables (Sounds and Letters, Word Meaning, Word Reading and Word Study Skills), the differences noted in grade five appeared in Arithmetic Comprehension, Social Studies and Science. At this time no logical explanation can be offered for such results.

To this point, no mention has been made of the differential effects of the program on males and females. Although the null hypothesis of no sex differences was rejected at the kindergarten level, as well as in grades three and five, no significant trends are apparent. In two of the three significant multivariate sex main effects (level K and grade 3), no individual univariate values reached significance. However, of those sub-tests appearing to account for the major portion of the variability between the sexes, the sub-tests differed as to favoring one sex or another, without exception. Stated otherwise, in each situation where significant multivariate values were evident, one of the major contributors to this variability would show larger increases by the males, and the other, the larger increase by the females.

As indicated above, no single grade showed consistent increases by one sex or the other as a result of the physical education program. However, of interest is the fact that the females showed greater gains in the subject areas of Letters and Sounds (kindergarten controls), Paragraph Meaning (grade three experimentals and grade five experimentals). This indicates that the increases in the sub-test of Paragraph Meaning, in favor of the experimental school, were largely due to the gains made by the female pupils. Similar reasoning may be applied to the increases in the sub-test of Letters and Sounds by the control females. Conversely, the males accounted for the greater portion of the increases in sub-tests involving the Environment (kindergarten controls), Arithmetic Concepts (grade three experimentals), and Science (grade five experimentals). Thus, it can be seen that few trends have evolved with reference to the sex differences noted in the results of this study. Perhaps the most interesting point to emerge from a consideration of the sex main effect is the fact that the respective sexes showed greater gains in those subjects which have been traditionally considered "female-oriented" (language arts) and "male-oriented" (Arithmetic and Science). This is in opposition, however, to the results provided by Minuchin (1966), in which the author did not find the boys to be better "problem-solvers" or the girls to excel in more "imaginative" and "introspective" subjects.

The only significant school x sex interactions were noted for grade two and grade four subjects. Since contradictory results were obtained with respect to the performance of the males and females in the control and experimental schools, in terms of the respective increases in academic achievement total and mental ability (grade two), little significance is attached to this statistically significant interaction.

Of interest is the fact that Ismail (1967) reported a significant School x Sex interaction on the variable "mental ability" when studying the effects of a physical education program on grade five and six pupils. Ismail found that higher mean intelligence scores in boys were associated with the experimental rather than the control groups, while in girls, opposite results were obtained with higher mean intelligence scores being associated with the control rather than the experimental groups. In the present investigation, the significant interaction for grade four, AAS7, indicated opposite findings. Higher mean scores in boys were associated with the control school while, for girls, higher mean scores were found in the experimental school.

Summary and Implications of the Discussion

As indicated in the preceding paragraphs, the data obtained in this study indicate few consistent results when examined across the six grade levels, kindergarten through grade five. Trends are conspicuously absent with the exception of the main effects for School. As noted, the physical education program did not have a facilitating effect at the kindergarten or grade one levels. Following non-significant results in grade two, the experimental program appeared to slightly enhance the academic progress of those pupils enrolled in grade three at the experimental school. The shift continued and extremely significant increases in academic variables were noted by those pupils having undergone the experimental program in grade four. Although the superiority of the experimental students was not established at the fifth grade level, nevertheless, a slight trend across the six levels was noticeable.

Investigating the relationships between perceptual and cognitive processes, Bibace and Hancock (1969) tested the oft-held theoretical assumption of the mastery of lower order (perceptual-motor) processes as necessarily prior to higher order (cognitive) processes, i.e., scholastic achievement. The results of their study led the authors to conclude that the theoretical assumption must be at least qualified and that the clinical-pedagogical practices based on this assumption needed to be re-examined. The present investigation supports the findings of these authors in that little evidence is produced to support the hypothesis that those individuals participating in a physical education program, consisting in part of perceptual training, achieve better than those not participating in such a program. A similar hypothesis (Myers and Hamill, 1969), in which the authors proposed that motor activity was a precursor to, or a useful adjunct to, skills which are essential for academic achievement, is another approach that requires further investigation in light of the findings of the present study.

Seefeldt (1970) notes that:

> "...the results of perceptual-motor training programs, with few exceptions, indicate that training is specific to the skill which has been practiced. Programs based on the hypothetical transfer of improvement in perceptual-motor skills to reading achievement or readiness for reading have generally met with failure." (p. 11)

The above is not surprising in view of the fact that specificity of training, in both verbal and motor skills, has been well documented (Henry, 1958; Williams, 1969; Singer, 1966; Bachman, 1961; Henry and Rogers, 1960). Thus, it appears that "on the basis of present knowledge, we cannot assume that what is learned in one skill will transfer to another" (Seefeldt, p. 21).

In view of the results of this study, it is possible that the approach taken by Humphrey (1965) should be seriously considered. Humphrey is of the belief that direct teaching of academic skills, through the medium of games and physical activity, is superior to those programs relying on transfer, with respect to producing changes in academic achievement. In this approach, the author devises active games in which academic concepts are directly involved. Thus the pupils, in order to participate maximally in the game situation, must understand the concepts necessary for participation in the activity. Thus, the possibility exists that academic concepts may be strengthened to a greater degree through the use of the physical education medium as employed by Humphrey, as opposed to the programs relying on transfer from one task to another. This is not to say, however, that the approach undertaken in this study is without value. Future investigations which avoid the limitations noted in this study may produce different results with respect to the effectiveness of motor-oriented programs on the academic functioning of the child.

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Purpose and Hypotheses

The purpose of this study was to investigate the effects of a one-year, objective-centered, sequential program of physical education upon the academic achievement and mental ability of male and female children enrolled in kindergarten through grade five. Two hypotheses were thus proposed: (1) a one-year, objective-centered sequential program of physical education would not significantly affect the academic achievement and mental ability of elementary school children, at any level, kindergarten through grade five; (2) a one-year, objective-centered sequential program of physical education would not affect males and females in a significantly different manner, at any level, kindergarten through grade five, with respect to academic achievement and mental ability.

Procedures

Two schools, one experimental and one control, were selected from the Waverly School District. The total sample included kindergarten (111), grade one (119), grade two (92), grade three (99), grade four (71), and grade five (95). Three tests, the Stanford Early School Achievement Test (SESAT), the Stanford Achievement Test (SAT), and the Otis-Lennon Mental Ability Test, formed the battery administered to the children. The experimental program consisted of a physical education program stressing the total development of the child and thus, particular activities were presented to enhance his/her social, emotional, cognitive and physical functioning. The control school received no formal physical education classes throughout the entire duration of the study. A series of multivariate covariance analyses were employed to determine if significant differences existed between the control and experimental groups with respect to the dependent variables, the post-test academic achievement and mental ability scores.

Results

1. Statistically significant differences were noted, in favor of the experimental school, for academic variables in Grade 4 (Academic Achievement Total, Word Meaning, Mental Ability) and Grade 5 (Science).

2. Statistically significant differences were noted in favor of the control school for academic variables in kindergarten (Academic Achievement Total, Letters and Sounds), Grade 1 (Academic Achievement Total, Word Reading, Word Study Skills) and Grade 5 (Arithmetic Comprehension, Social Studies).

3. Statistically significant differences were noted in favor of the females for academic variables in Grade 5 (Paragraph Meaning).

4. Statistically significant differences were noted in favor of the males for academic variables in Grade 5 (Science).

5. A statistically significant School x Sex interaction noted for Grade 2 (Mental Ability) indicated that within the experimental school, larger gains were registered by the females. Within the control school, larger increases were made by the males. Opposite results were obtained for Academic Achievement Total.

6. A statistically significant School x Sex interaction noted for Grade 4 (Arithmetic Concepts) indicates that within the experimental school, the largest gains were registered by the females, while in the control school, opposite results were obtained.

Conclusions

Within the limitations of this study, the following conclusions are noted.

1. The one-year, objective-centered, sequential program of physical education did not facilitate the learning of academic concepts, as measured by standardized academic achievement and intelligence tests, of children in grades kindergarten through five. Although isolated effects were noted throughout the grade levels, no consistent trends were evident.

2. The one-year, objective-centered, sequential program of physical education had no differential effect on the males and females in the experimental group. Although isolated sex differences were in evidence, no consistent trends were noted throughout the study.

Recommendations

Further investigations concerned with the effects of physical education programs upon the academic functioning of elementary school children should consider the following points:

1. The emphases of participating schools or school systems should be more clearly evaluated, with respect to their approach to teaching, i.e., "academic" or "socialization" at the outset of the investigation.

2. Spurious results are often obtained when only one measure of a particular trait is taken. It is suggested that at least two measures of each academic ability, i.e., Arithmetic Concepts, should be included in future studies of this type.

3. More meaningful measures should be developed to evaluate the effects of perceptual-motor and physical education programs on academic achievement and intelligence. It is very possible that many essential knowledges and abilities are enhanced by motor-oriented programs, yet are not in evidence due to the nature of the evaluative instruments. Measures of perception, imagination and creativity are examples of variables which might be included in evaluative batteries for future program testing.

4. It was concluded by the author that many overriding variables (teacher effect, program orientation, completeness of material and instructions) resulted in the inability of this investigation to produce clear and unbiased estimates of program effects. Thus, it is suggested that future studies attempt to control for those variables which may have obscured the findings of this investigation.

5. A closer examination should be taken of those programs (Humphrey, 1965), or modifications of such programs, emphasizing specificity of training. To date, very little evidence is forthcoming to suggest that the learning of academic concepts will "transfer" from a program of motor activities. However, if specific academic concepts are taught, through the medium of physical activity, more positive results may be in evidence.

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