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The Relationship of Physical Fitness and Academic Achievement of Children in Grades Three and Six

by

© Frederick Ivan Bell

A Thesis

Submitted to the Faculty of Graduate Studies and Research in Partial Fulfillment of the Requirements for the Degree of Master of Education

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submitted by Frederick Ivan Bell

in partial fulfilment of the requirements for the degree of Master of Education.

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Date July 30, 1981

DEDICATION

To Ivan and Isabelle,

whom I'll always love and remember.

ABSTRACT

The purpose of this study is to examine the effects of a daily physical education program as compared to a more traditional program upon physical fitness and academic achievement in elementary school children. Thirty children, fifteen girls and fifteen boys, were randomly selected from each of grade three and grade six in each school. The subjects were tested initially in September/October 1977 and again in May/June 1978. Activity levels as observed in physical education classes were higher in the experimental school than the control school. Yearly programs had only slight differences in content with the experimental school emphasizing running, swimming and skating more than the control school. Analysis of pretest data indicated no significant differences between the two schools in either fitness scores or academic achievement scores within the two grade levels. Grade six boys scored significantly higher than the girls in PWC_{170} while in language, the grade six girls scored higher than the boys. No significant differences existed in post-test results for physical fitness or academic achievement in grade three. In grade six the experimental group scored significantly higher in physical fitness whereas there were no differences in academic achievement results. The daily physical education program therefore had positive effects on the fitness levels of grade six students and did not detract from the academic achievement of either grade three or grade six students.

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CHAPTER I

INTRODUCTION

The purpose of this study is to examine the effects of a daily physical education program as compared to a more traditional program upon physical fitness and academic achievement in elementary school children.

The goal of daily physical education has been recognized as an educational need by many levels of administration. In 1976 a subcommittee of the Canadian Association for Health, Physical Education and Recreation which was examining elementary school physical education programs in Canada reported that a good physical education program should be implemented daily with a minimum of one hundred fifty minutes each week. (C.A.H.P.E.R., 1976). The United Nations Educational, Scientific and Cultural Organization (1964) made specific reference to the amount of time allocated to physical education when it stated,

> "an individual, whatever his ultimate role in society, needs in his growing years a due balance of intellectual, physical, moral and aesthetic development ... between one third and one sixth of the total time should be devoted to physical activity." (p. 54)

Although there has been a recommended minimum amount of time for instruction in physical education there are a number of reasons that prevent the majority of elementary schools from reaching this goal: teachers who have received little or no professional training in physical education, limited facilities and equipment and perhaps the greatest

obstacle - changing traditional attitudes towards physical education as a time of play to a subject that requires knowledgeable instruction and individual skill development.

Programs such as the Millgrove Project (Jeglum, 1977) have been initiated in an attempt to qualitatively and quantitatively assess the effects daily physical education has on the intellectual, psychological and physiological development of elementary school students.

In recent years schools have encountered increasing pressure from the general public to improve the basic academic skill levels of Canadian school children. Increasing the time allocated for physical education to one hundred fifty minutes in weekly timetables decreases the total time available for instruction in the "academic" subjects. Therefore school administrators, teachers and parents are concerned with the resulting indirect effect daily physical education may have on the academic development of students.

A second major purpose of this project was to monitor the effect participation in a daily program of physical education had on physical fitness levels of elementary school children. The research discoveries of Dr. Don Bailey (1973) blatantly indicate the decline of aerobic fitness in school age children and the need for change in physical education programs if we are to reverse this trend. Although physical fitness is not the sole criterion with which to evaluate the merit of a particular program, evidence suggests that schools need to be more sensitive to increasing students' levels of cardiovascular fitness. Research must therefore be conducted to determine not only the optimal frequency of such

programs but the intensity and duration of exercise which will encourage fitness development in children.

One of the major responsibilities schools have is to prepare children to function effectively in an adult world. When one considers many of the major health related problems such as coronary heart disease and lung disease are related to individual lifestyles in North American adults, it becomes apparent that teachers "must motivate young Canadians to become concerned about their lifestyles and to stimulate them to do something about them." (Beauchamp, 1977, p. 1). Positive attitudes towards fitness that are developed at a young age through involvement in enjoyable and challenging physical education programs may assist in limiting these lifestyle related problems in future generations. Physical educators must continue to evaluate physiological, intellectual and sociological variables in order to determine the optimal amount of time, duration and intensity needed to produce the desired changes in our society.

Statement of the Problem

Specifically, this study will investigate the following problems:

1. To determine the relationship of time allocated to physical education to levels of physical fitness as measured by a physical work capacity submaximal bicycle ergometer test. (PWC_{170})

2. To determine the relationship of time allocated to physical education to levels of academic achievement as measured by the Canadian Test of Basic Skills.

Hypothesis

There are three hypotheses which will be tested in this study:

1. There will be no significant differences in cardiovascular fitness between grade three students subject to the daily physical education program and those subject to the control program.

2. There will be no significant differences in cardiovascular fitness between grade six students subject to the daily physical education program and those subject to the control program.

3. There will be no significant differences in levels of academic achievement between those students subject to the daily physical education program and those subject to the control program as indicated by performances on the Canadian Test of Basic Skills.

Limitations

This study was limited by:

1. The two physical education programs as established prior to the development of this project. A physical education major taught all physical education classes in the control school whereas home room teachers were responsible for the physical education program in the experimental school.

2. The limitations inherent within the PWC_{170} and academic achievement tests.

3. The number of testers in both fitness and academic achievement varied [redacted] pre-test to post-test.

Delimitations

This study was delimited to:

1. A randomly selected sample of one hundred and twenty grade three and grade six students from Millgrove and Brookwood elementary schools in Spruce Grove, Alberta.

2. A pre-test - post-test experimental design.

3. A PWC_{170} bicycle ergometer test to determine levels of physical fitness. This test is submaximal and includes three consecutive four minute bouts of exercise at progressively higher work loads in order to produce prescribed heart rates.

4. A series of the Canadian Test of Basic Skills to determine levels of academic achievement. This series of tests was standardized on a group of 30,000 children from a stratified random sample of two hundred and twenty five schools from the English speaking sector in all provinces of Canada. (King, 1977). The tests are intended to evaluate generalized educational skills and abilities not content achievement.

Definition of Terms

1. Physical Fitness. The predicted rate of work expressed in Kilopond metres (Kpm) per minute or in watts at a steady state heart rate of 170 beats per minute as measured by the bicycle erogometer test developed by Howell etal. (1968)

2. Grade Equivalent Scores. A two-digit score determined from a test raw score the first digit of which indicates the grade level of performance, the second digit the month. A score of 6.2 would indicate a level of performance at the second month of grade six.

3. Academic Achievement Reading. A grade equivalent score based on results from a reading comprehension test.

4. Academic Achievement Language. A composite grade equivalent score based on results from sub-tests in spelling, capitalization, punctuation and word usage.

5. Academic Achievement Mathematics. A composite grade equivalent score based on results from sub-tests in problem solving and mathematical concepts.

6. Classroom Generalist. Those teachers graduating in elementary education without a major specialization in physical education.

7. Secondary Physical Education Major. Those teachers graduating in secondary education with a major in physical education.

8. Physical Education Specialist. Those teachers graduating in elementary education after having completed a physical education degree.

CHAPTER II

A REVIEW OF THE LITERATURE

The Physiological Need for Exercise

Participation in regular physical activity can cause significant changes in the functional capacity of the heart and lungs, the strength of bones and muscles and body composition. Astrand, Engstom, Eriksson, Karlberg, Nylander, Saltin, and Thoren (1963) in a study involving thirty teenage girl swimmers reported a significantly higher functional capacity as measured by maximal oxygen uptake after a lengthy training program. Similar results were found by Dobelin and Eriksson (1972), Ekblom (1969), Eriksson (1972), Eriksson and Koch (1973), Harman Brown, Harrower and Deeter (1972), and Lussier and Buskirk (1977). Regular exercise also resulted in a significant decrease to submaximal heart rate (Eriksson & Koch, 1973; Harman Brown et al., 1972; Steward & Saltin, 1976) and a significant increase in heart volume (Astrand et al., 1963; Ekblom, 1969; Eriksson & Koch, 1973) vital capacity and total hemoglobin (Astrand et al., 1963; Eriksson, 1972). Physical work capacity showed significant increases after a two month and a seven month training program in elementary school students. (Gatch & Byrd, 1979; Vaccaro & Clarke, 1978) Evidence appears to indicate that in pre adolescents functional capacities respond to endurance type training.

Exercise can also effect bone composition and development in pre-adolescents. Malina (1969) indicated that, "the normal forces of pressure and tension resulting from exercise lead to the formation of new bone if the force acts on a surface adapted to resist it." (p. 23)

Malina also states that inactivity can have detrimental effects on bone development by increasing the excretion of calcium and nitrogen resulting in decalcification of the long bones.

Parizkova (1963, 1968) discovered that physical activity had significant effects on the body composition of young boys. She states:

> "The influence of intensity of physical activity on body composition is evident throughout life and causes an increase in lean body mass at the expense of fat. Substantial reduction in physical activity leads to changes involving a disproportionately greater fat content and a slight reduction of lean body mass." (p. 672)

Similar results were reported by Wells, Jockl and Bohanen (1964) in young girls.

Although research substantiates the positive influence exercise has on bodily functions, Bailey (1973) indicates that there is actually an increase in postural defects and obesity in school age children. Results from his longitudinal study reveal:

> "For the ordinary Canadian child, not the athlete or the exceptional skilled, physical fitness as expressed by aerobic power factoring out size seems to be a decreasing function of age from the time we put him behind a desk in our schools." (p. 427)

Clearly then, present elementary school programs are not having a positive effect on the fitness development of participating students. Understanding the values of physical exercise can only lead to providing children with proper facilities and increased opportunities for participating in regular, beneficial activity.

Evaluation of Physical Working Capacity

Many tests have been developed to evaluate human physical fitness both in a laboratory setting with access to controlled, scientific equipment and in a field situation where direct analysis of fitness variables is much more difficult. Astrand and Rodahl (1977) indicate that from a medical viewpoint any test utilized to evaluate physical fitness must be based on sound physiological principles. Of the instruments and tests available, Astrand and Rodahl recommend the bicycle ergometer since, "the energy output or the oxygen uptake can be predicted with greater accuracy then for any other type of exercise." (p. 337)

There are two physiological bases to evaluate physical working capacity. First, there is a positive, linear relationship between heart rate and submaximal workload and secondly, any increase in cardiorespiratory endurance is attended by a decrease in heart rate at submaximal workloads. Heart rate reaches its maximum value at slightly lower work rates than oxygen consumption thereby incurring a bias in the estimate of maximal oxygen consumption of approximately 0.3 litres per minute. Combining this with the individual variations in heart rate of up to ten percent results in considerable methodological error. (Wyndham, 1967; Astrand & Rodahl, 1977) However, the true value of the submaximal bicycle test lies not in its ability to predict exact maximal oxygen consumption but in controlling and measuring the effectiveness of a training program over a period of time.

Physical working capacity and physical performance are affected by a number of variables including:- physical size and body proportions, energy release systems, energy sources available, strength, speed of movement, motor skills and psychological factors. The PWC_{170} bicycle test is a popular submaximal method for evaluating physical fitness which minimizes the effects of the latter three variables. Pedalling frequency is controlled, very little skill is involved in riding a stationary bicycle and the test is not psychologically demanding since it is not exhaustive.

Daily Physical Education and Physical Fitness in School Age Children

The first study involving daily physical education occurred in Vanves, France in the early 1950's. (Encausse, 1957) The traditional school day was altered such that one third was devoted to academic subjects, one third to fine arts and one third to physical education. Although no physiological variables were evaluated and no statistical analysis was done on results, this study did reveal that students who participated in the experimental program maintained levels of academic achievement not significantly different from national, academic norms. The Vanves study has provoked North American educators to analyse the effects of daily physical education and special training programs on academic achievement and various physical fitness parameters.

Johnson (1969) analysed the effects of five versus two and three day a week physical education classes on fitness, adipose tissue and growth in seven hundred and forty three grade eight boys and girls. Physical fitness was measured by a variety of tests;

boys: standing broad jump, jump and reach, push ups, pull ups, 160 yard race, 600 yard run-walk.

girls: standing broad jump, flexed arm hang, curl up and 600 yard run-walk.

Body density and percent body fat as well as height-weight were measured. After two years, the five day a week boys group was superior in standing broad jump, push up and pull up. The girls group involved in daily physical education was superior in only standing broad jump. There were no significant differences noted for percent body fat or growth curves. No description is offered concerning the intensity of exercise during these programs and no statistical analysis was done on the fitness variables thus limiting the conclusions that can be derived from this study.

A similar program was analysed by Kemper, Verschuur, Ras, Snel, Splinter and Tavecchio (1976). Seventy boys ages twelve and thirteen were involved in a five versus three lessons a week program. The authors evaluated PWC_{170}, percent fat, hand grip, vertical jump, flexed arm hang and a sit-reach test. Only hand grip proved to be significantly greater in the experimental group. Once again no descriptive details are provided of either program to indicate the intensity or nature of exercise. Therefore, " ... the effects of two extra lessons in physical education upon 12 and 13 year old boys could not be confirmed." (p. 324)

Bar-Orjo and Zwiren (1973) examined three physical education programs of two, three and four lessons a week for grade four students. Each class was assigned to either a regular program with calisthenics and movement games or an experimental program with strenuous interval training in each lesson. Dependent variables evaluated included maximal oxygen uptake as measured by a treadmill test, heart rate and various anthropometric parameters. After nine weeks, variations in submaximal heart rate during the treadmill test were the only significant differences between the experimental and regular programs for boys. No significant differences were reported for the girls. Variations in submaximal heart rate were greater for the group having three lessons a week than for the other two groups however, the authors fail to statistically verify this difference.

Cumming, Goulding, and Bagglay (1969) studied fitness changes in grade six and grade ten classes in four Canadian schools from September to June. One was a private school which had a daily physical education program and a specialist teacher. The second was also a private school but there was no gymnasium and no standard physical education program however there were many outdoor programs in snowshoeing, canoeing and farming. The third was a city high school with a specialist teaching two forty five minute periods per week. The fourth school was a city elementary school with two forty minute periods of physical education taught by the classroom teacher. The authors evaluated fitness by utilizing PWC_{170} and maximal oxygen uptake tests. Results showed no changes in PWC_{170} or maximal oxygen uptake. The authors conclude that increasing the number of hours in a physical education program will not necessarily lead to an increase in cardiovascular fitness.

The Blanchard Project (Martens, 1976) was a three year study of the effects of daily physical education on academic achievement, psychological attitudes and physical fitness. Among the fitness appraisal items was PWC_{170}. All variables were initially measured in 1974 and this data functioned as the control level. The experimental physical education program involved two hours in the gymnasium, one hour in the classroom or out of doors and one afternoon of bowling, skating or swimming each week to total approximately five hours of instruction per week. The 1975 data, when compared with the 1974 control level showed significant improvement of the means of PWC_{170}/kg for grades five, six and seven whereas, the 1976 results showed significant decreases for grades five and seven. The authors could not explain the discrepancy in results.

The Saskatchewan Department of Education (1976) conducted an investigation into the degree of implementation of its provincial curriculum and physical fitness levels in grade four students. Using a checklist to determine the degree of curriculum implementation, ten grade four classes were selected as a low implementation group and thirteen grade four classes were chosen as a high implementation group. Students were pre-tested in the fall of 1974 and post-tested in the spring of 1976. Analysis of covariance using the pre-test score as the covariate indicated that the students in the high implementation classrooms scored significantly higher than the low implementation group in Cooper's endurance run, a four minute run-walk test.

Physical Fitness, Physical Education Programs and Academic Achievement

Historically, the relationship between physical fitness and academic achievement was first analysed at the college level. Weber (1953) discovered a significant correlation (0.41 at p .05) in college freshman between physical fitness as measured by performance in sit ups, pull ups, 100 yard piggy back run and a 300 yard shuttle run and academic achievement as measured by grade point averages. The four fitness items were combined to give a composite Physical Efficiency Profile however, only one component of physical fitness is evaluated, muscular strength endurance, which does not provide an adequate, comprehensive assessment of fitness levels.

Hart and Shay (1964) attempted to discover a similar relationship in college sophomore women. Academic achievement was a cumulative index score calculated as a ratio between grade points and semester hours. When Academic Aptitude, as measured by scores on mathematical and verbal portions of an aptitude test, was held constant, there was a significant correlation (0.66 at p .01) between academic achievement and physical fitness. No description of how physical fitness was evaluated was provided therefore, any conclusions from this study are suspect.

Arnett (1968), utilizing eight hundred and twenty seven freshman college women, evaluated physical fitness using a composite score based on results of performance in sit ups, standing long jump, flexed arm hang and a three minute step test. Once again, this is a narrow indicator of physical fitness since only muscular strength endurance is examined. Academic achievement was based on grade point averages at the end of the

fall and winter terms. Results revealed a significant correlation between grade point averages and fitness scores (0.56 at p. 01). Analysis of variance of grade point scores among high, medium and low fitness categories showed a significant difference between grade scores and fitness levels suggesting that greater fitness correlates positively with higher academic achievement.

Edwards (1967) and Eidsmoe (1964) examined grade point averages of athletes involved in college sports and found they scored higher than control groups. No statistical analysis of results was done in either study thus eliminating the possibility of any conclusive statements.

Grade point averages and participation on athletic teams have also been examined in high school students. (Airoldi, 1967; Conor, 1954; Schurr & Brookover, 1970). In all cases students participating on athletic teams scored higher than control groups however, no statistical analysis was performed on the data. Pangle (1956) reported no significant differences in grade point averages between high school basketball and football players and a control group of nonparticipants.

Chisson (1970, 1971) investigated the relationship between performance on various motor tests and academic achievement in first and third grade children. In both studies significant correlations existed between these two variables for grade one (1971) and grade three (1970). Rarick and McKee (1949) conducted a descriptive study examining motor performance and academic achievement in grade three students. He concluded that;

1. Superior performers on the motor test grew older, more obese, heavier and stronger.

2. Superior performers had a greater number in the high academic ratings.

The Board of Education, North York (1973) evaluated the effects of a daily physical education program on performance in eight psychomotor tests and academic achievement. Subjects for this study were grades one, three and five students although grade one was not subject to academic testing. The physical education program (PEP) was initiated in 1972 (pre-test) and completed in 1973 (post-test). The basic aim of PEP was to develop a child's skills in the areas of balance, rhythm, lateral and directional movement, body-spatial organization and reaction-speed dexterity. Psychomotor tests were designed to evaluate these concepts. Academic achievement was based on results from a mathematics problem solving test, a subtest of the Metropolitan Achievement Test. The pre-test and post-test results were used to determine a gain score although there was a discrepancy in the number of subjects from pre to post test. These scores were then compared to expected gain scores developed by the Department of Physical and Health Education.

Results of the psychomotor tests indicated that pupils participating in PEP made reasonable growth in the development of psychomotor skills. Grade one students met or exceeded the growth expectations in seven of eight subtests while grade three and five students met or exceeded growth expectations on six of eight subtests. In the area of mathematics problem solving, pupils at the grade three level achieved the expected gain while grade five pupils made gains which significantly exceeded the expected gains.

Although significance was attached to some of the results no statistical analyses of the data is provided. As well, expected gain scores were developed for each subtest but no explanation is given describing the criteria or method used to determine these values. Conclusions about the merits of daily physical education arising from this study are therefore rather limited.

The Saskatchewan Department of Education (1976) analysed the effects of daily physical education on physical fitness as measured by Coopers' endurance run and academic achievement as measured by mathematics and reading subtests of the Canadian Test of Basic Skills. Thirteen grade four classes were selected on the basis of implementing daily physical education into their school programs and were compared to ten grade four classes that showed a low degree of implementation of the provincial curriculum.

Students were pre-tested in the fall of 1974 and post-tested in the spring of 1976. Analysis of covariance using the pre-test scores as the covariate was used to determine if any statistically significant differences existed between post-test scores of the two groups. Results indicated that students in the high implementation classrooms scored significantly higher in the reading subtest and both mathematics subtests as well as on the endurance run.

The daily physical education program in Blanshard Elementary School, Victoria, British Columbia (Martens, 1976) described earlier in this review utilized all subtests of the Canadian Test of Basic Skills to

evaluate the program's effect on academic achievement. Grade three and six students were initially tested in 1974 (control data) and again in 1975 and 1976. Results showed that academic performance of pupils involved in this study in 1975 and 1976 was at least as good as academic work performed in 1974 even though they were spending a considerably larger portion of the school day in physical activity.

Although the Canadian Association of Health, Physical Education and Recreation is recommending daily physical education to enhance the physical development and levels of physical fitness in Canadian elementary school children, there is very little information available describing the program content which would realize these stated goals. (C.A.H.P.E.R., 1976) Continued analysis, both analytical and descriptive, of daily physical education must be undertaken to determine the maximal amount of time that should be devoted to physical education.

The relationship between daily physical education programs and academic achievement has been examined by very few others. Most of these studies lack reliable statistical analysis and are therefore very difficult to replicate or control. In addition they did not include an analysis or description of intervening variables such as teaching styles, methodologies and work intensity which affect the teacher-learner process and the learning outcomes.

CHAPTER III

METHODS AND PROCEDURES

Subjects

The subjects for this study were drawn from two elementary schools in the town of Spruce Grove, primarily a commuting town outside Edmonton, Alberta. In the fall of 1977, a sample of fifteen boys and fifteen girls in grades three and six was randomly selected from class lists in the two schools to yield a total initial sample of 120 students. Parents of students were notified prior to the study to inform them about the purpose of the study and to obtain consent for their childrens' inclusion.

The two schools varied markedly in the program composition of the school day. Millgrove, the experimental school, allocated one hour per day for each of the following subjects: physical education, fine arts and creative language. In almost all cases, the home room teachers taught their own plysical education classes. On staff were two physical education specialists and three other teachers who had a major in elementary school physical education. Brookwood, the control school, had a more common school program which included two thirty minute periods of physical education per week. All physical education classes in this school were taught by one physical education major, this teacher being initially trained for secondary physical education.

Table 1 provides a description of the sample according to sex, grade and school. The study began with fifteen students in each group however only the data for students completing all pre and post tests is included in the results.

Table 1. Description of the subjects according to sex and grade.

		Experimental School		Control School	
		Pre-test	Post-test	Pre-test	Post-test
Grade 3	Boys	15	15	15	14
	Girls	15	13	15	15
Grade 6	Boys	15	13	15	15
	Girls	15	15	15	10

Table 2 provides a description of the housing situation of the subjects in the experimental and control schools. The control school

Table 2. Description of the subjects according to the type of housing for each grade and school.

	Non-Bussed Students			Bussed Students	
	Houses	Apartments	Mobile Homes	Acreages	Farms
Grade 3					
Control N = 29	27			2	
Experimental N = 28	14		3	8	3
Grade 6					
Control N = 25	21	2		2	
Experimental N = 28	11		1	11	5

subjects resided primarily in urban dwellings while the experimental school had a large number of students living on acreages and farms. The age of subjects as of the first of October 1977 is summarized in Table 3 with little variation existing between the two schools.

Table 3. Means and standard deviations for chronological age in months for each grade, sex and school.

		Boys		Girls	
		Grade 3	Grade 6	Grade 3	Grade 6
Experimental	$\bar{X}$	100.6	133.5	99.8	138.7
School	SD	6.3	10.7	4.9	6.8
	n	15	13	13	15
Control	$\bar{X}$	98.5	138.3	99.2	135.3
School	SD	3.8	9.6	3.9	5.3
	n	14	15	15	10

Methods and Procedures

Two variables were initially measured in October, 1977 and then again in May, 1978 on a pre-test - post-test basis. The physical working capacity at a heart rate of 170 was calculated on the basis of performance on a submaximal bicycle ergometer test developed by Howell et al (1968). The heart rate was monitored by timing thirty beats with a stethoscope and stopwatch beginning with the last twenty seconds of each minute. The pedal revolutions of the bicycle were also recorded at the end of a minute. Prior to testing at each school, the ergometers were calibrated. The second variable evaluated was academic achievement as measured by the Metric Version of the Canadian Tests of Basic Skills. Three fundamental skills were chosen from the total test battery; reading, language skills and mathematics. These areas are often referred to as the "core" or basic subjects in an academic program and were therefore selected to represent academic ability for this study. The reading test required a maximum of fifty five minutes; the language skills, which involved four sub tests (spelling, capitalization, punctuation and usage) required sixty seven minutes; and the mathematics skills which involved two sub tests (mathematics concepts and mathematics problem solving) required sixty minutes. The tests were administered in September, 1977 by the home room teacher and then in June, 1978 by the author. The September testing was done prior to the initiation of this study in the schools however the preparation and all the directions for administering the tests are

completely standardized in the Teacher's Guide which each examiner followed verbatum thus minimizing possible effects of different testors. Both pre-test and post-test raw scores were converted to grade equivalent scores which indicate the grade level at which an average student would make this score. In language and mathematics a composite score was calculated by adding together the grade equivalent scores of the sub-tests and dividing by the number of sub-tests. This is a standardized procedure for language and mathematics as outlined in the Teacher's Guide to the Canadian Test of Basic Skills (King, 1977).

A quantitative and qualitative analysis of each physical education program was undertaken beginning in February, 1977. The time and intensity of the childrens' activities were evaluated by observing randomly selected classes. Each activity was classified according to four intensity levels: no activity, activity producing a heart rate below 120, from 130 to 150 and over 150. All of these observations were made by the same observer (Cote, 1979) and validation of the classification process was done in two sessions that involved a total of fifteen heart rate measurements on children five to seven years of age. The classification of the intensity level during the observed physical education classes was assessed with regard to the average activity level in the class. The reliability of the classification process was verified on a continuous basis from observations of grade two, four and five classes. The class average activity level was classified and this classification was subsequently verified by monitoring the heart rate of one or two children over a ten second period using a palpation technique.

The variety of activities and length of time allocated to each activity during the school year were monitored in each school by the teachers responsible for the physical education programs. Weekly activity sheets (Appendix I) were completed by teachers and a percentage of the total school year was calculated for each major component of the physical education program.

An attempt was also made to qualitatively assess the differences in teaching styles of the teacher in the two schools with respect to the physical education component of the program. Teacher behavior was observed and recorded by utilizing a revised teacher observational instrument developed by Robbins (1973) (Appendix II). Observations of grades one, two and three were conducted in the control school and grades three and six in the experimental school. All observations were done by the same observer for the duration of a physical education lesson. Due to the large number of teachers involved in the experimental physical education program the number of observation sessions was rather limited.

Statistical Design

A two-way analysis of variance was performed to test the differences between the two schools in pre-test results. This analysis was done for each grade using the treatment group and sex as the independent variables. An analysis of covariance with the pre-test score as the covariate was conducted on the post-test data to determine any differences in results between the schools. The accepted level of significance was $p \leq .05$. The analysis was performed using the statistical package for the social sciences (SPSS), Version M.

CHAPTER IV

RESULTS AND DISCUSSION

The Physical Activity Level During Physical Education Classes

The results of the observation of the activity level of some of the classes are summarized in Table 4. The number of classes on which the data was based is low, especially for the control school since the same teacher taught all the physical education classes. Of the two classes for which complete data is available, the experimental school showed greater total time spent in an activity session. Activities ranked two and three, which are of sufficient intensity so as to produce some training effect, seem to be performed for longer periods of time in the experimental school.

The grade three class in the experimental school had an average of 4.5 minutes of activity producing a heart rate of 130 - 150 beats per minute as compated to 1 minute at the same level in the control school. There was no observed activity in the control school that would produce a heart rate of greater than 150 beats per minute whereas in the experimental school 0.6 minutes were recorded.

The evaluation of the physical activity level in physical education classes was not done systematically therefore limiting generalizations which can be made from these results. However, the data would suggest that activity levels of sufficient intensity (i.e. heart rate greater

Table 4. Total time, in minutes, spent at different activity levels during the observed 30 minute classes.

		Experimental School				Control School			
Grade	* Activity level	No of class	$\bar{X}$	min	max	No of class	$\bar{X}$	min	max
1	0	3	4.2	2.5	6.0	3	7.7	7.3	8.2
	1		15.3	9.0	25.3		10.7	9.5	11.5
	2		8.8	4.5	16.8		3.1	2.5	3.5
	3		2.0	0.0	6.0		1.0	0.0	2.2
3	0	5	11.3	8.16	14.7	2	4.3	4.1	5.2
	1		16.2	8.0	27.0		5.1	5.0	5.2
	2		4.5	1.0	10.0		1.0	0.6	1.3
	3		0.6	0.0	2.0		0.0		
6	0	3	11.4	5.0	14.7	0			
	1		22.7	20.7	24.0				
	2		1.6	0.0	4.7				
	3		0.3	0.0	1.0				

* Activity Level

0 = no activity (rest)

1 = Heart Rate 129 beats per minute

2 = Heart Rate between 130 and 150 beats per minute

3 = Heart Rate greater than 150 beats per minute

than 130 beats per minute) to induce changes in physiological variables were performed for a longer duration in the experimental school. The monitoring of the intensity of exercise is critical if physical education programs are to enhance levels of physical fitness in elementary school students. (Antomi, Ito, Iwasaki & Miyashita, 1978; Roberts & Morgan, 1971; Selinger, 1968.)

The Variety and Duration of Physical Activities

The results of the weekly activity sheets are summarized in Table 5. Some differences exist in the aerobic fitness classes where the experimental school allocated 14% of the school year in grade three to this activity as compared to 5% in the control school. In the two grade six classes in the experimental school aerobic fitness activities accounted for 13% and 22% respectfully of the school year in comparison to 5% in the control grade six class. There is an obvious domination of games in the grade three program at the experimental school whereas the teacher at the control school attempted more creative dance activities in this grade. In grade six, the major difference is a heavier emphasis on gymnastics in the experimental school as compared to the control school.

The variety of activities students were exposed to in each of the schools was generally quite similar although the amount of time allocated to the various components of the physical education program varied between the two schools. The variety of activities in a physical education program is of secondary importance to the frequency and intensity of participation in those activities when considering changes in levels of fitness.

Table 5. Percentage of school year allocated to Core Activity areas.

School	Grade	Games	Gym	Dance	Fitness Activities	Out-of-School Programs	Movement Training	Other
Control	3	36	8	21	5	2	5	13
Experimental	3	60	7	7	14	12	-	-
Control	6	49	8	21	5	2	5	10
Experimental	6	39	26	16	13	6	-	-
		32	21	14	22	11	-	-

Teaching Styles

Observations of teaching style as presented in Table 6 are ranked according to frequency of use. Since all teachers in the experimental school taught their own class physical education, the number of classes observed is low when compared to the control school where the physical education specialist taught all physical education classes. The styles most frequently used by the physical education major at the control school included: physical education centered behavior that did not elicit a response in students, either command or authoritative directives and teaching questioning. The physical education specialist and one grade three teacher at the experimental school utilized physical education centered behavior and command directives as their dominant teaching styles.

The other grade six teacher in the experimental school utilized behavior confirming student response, correcting student behavior and extending student reactions as her dominant styles. The second grade three teacher in the experimental school was characterized by using physical education centered behavior, command or authoritative directions and teacher correcting student behavior as her dominant styles.

The evaluation of teaching style was performed on a limited basis and thus any discussion relating to teaching styles is quite restricted. Results seem to indicate that the physical education major, the physical education specialist and the grade three teachers used command questioning as their dominant teaching styles. The only teacher in the experimental school who did not utilize a direct approach was the other grade six teacher. Since all grade six data from the experimental school was combined no comparison of performances between the two programs is possible.

Sande (1968) compared a problem solving approach to a direct approach in grade one and two children and their effect on various fitness parameters including the Canada Fitness Test, strength items and balance. He suggests the direct method was more successful than the problem solving approach in performance of grade two students on the fitness test while in grade one there was little difference between the two methods.

Researchers have analysed the effects of physical education specialists and classroom teachers of physical education on levels of physical fitness in elementary school children. In most cases students taught by a

Table 6. Rank Order of the frequency of use of Teaching Styles in physical education classes.

	Rankings				
	Control School	Experimental School			
		Specialist	Classroom Generalists		
* Teaching Style	P.E. Major	P.E. 6A	Teacher 6B	Teacher 3A	Teacher 3B
1	1	1	6	3	1
2	12	-	7	-	-
3	2	2	4	2	2
4	9	-	-	9	-
5	12	-	-	9	-
6	3	3	7	1	4
7	7	7	1	4	5
8	9	8	-	7	-
9	7	5	7	5	6
10	5	6	7	7	3
11	6	7	3	6	7
12	8	-	4	-	-
13	11	-	-	-	-
Number of classes observed	9	2	2	2	1

* Appendix II

specialist teacher scored significantly higher on various fitness and motor tests than those students taught by classroom teachers. (O'Connor, 1969; Workman, 1968; & Zimmerman, 1959)

Results from this study do not concur with the research although a comparison between specialist and classroom teachers is difficult since there are three different classifications of teachers: in the control school the physical education program was taught by a secondary physical education major; in the experimental school classroom generalists and a physical education specialist taught the physical education program. In grade three the change in fitness level between pre and post tests was much greater in the experimental program (41.93 Kpm/min) than in the control program (27.22 kpm/min) (Table 47, Figure 5) Grade six had a similar trend with a change in the experimental school of 106.4 kpm/min compared to 33.7 kpm/min in the control school. (Figure 9) Ross (1960) discovered few differences in performances of grade five and six students on fitness tests when comparing the specialist and non specialist teachers but did indicate some sex differences. Girls tended to perform much better for the specialist while boys did so for non specialists.

This was not the case in this study. The girls in the experimental school where three of the four classes were taught by non specialist teachers showed a greater growth in physical fitness scores when compared to students in the control school who were taught by a physical education major. (Figures 5 and 9) Although the boys in the experimental school

revealed greater growth in physical fitness with non specialist teachers, other variables such as the increased frequency and intensity of activity when compared to the control school may have contributed to this result. Increasing the allotted time for physical education and utilizing physical education specialists may be positive factors if the desired outcome of increasing physical fitness is to be realized.

The Analysis and Discussion of Pre-test Data

Grade Three

The results of the analysis of variance for all grade three pre-test variables are presented in Tables 12 to 19. There were no significant differences in initial scores in PWC_{170}, reading, language and mathematics between the two programs or between sexes. As well, there were no significant interactions between the two schools and sex.

This indicates that the grade three classes in each school began the project at similar levels of physical fitness and academic achievement.

A comparison of levels of academic achievement between this program and the Blanshard Project (1976) is shown in Table 7. The pre-test results of this study are generally similar to those in the Blanshard Study with grade equivalent scores in the three subject areas approximately 3.0, the starting point for grade three in the Canadian Test of Basic Skills.

Table 7. Comparison of mean grade equivalent scores for academic achievement from different studies.

	Grade 3			Grade 6		
	Reading	Language	Mathematics	Reading	Language	Mathematics
Blanshard Project (1976) (Pre-test)	3.1	3.0	3.2	5.8	5.4	6.4
Blanshard Project (Post-test)	3.4	3.4	3.6	5.9	5.5	6.3
This Study (Pre-test) Experimental	3.3	3.1	3.0	6.3	5.9	6.1
This Study (Post-test) Experimental	4.1	4.0	3.9	6.5	6.5	7.0
This Study (Pre-test) Control	3.5	3.3	3.3	6.4	5.9	6.1
This Study (Post-test) Control	4.5	4.3	4.2	6.2	6.6	6.8

Grade Six

The results of the analysis of variance for initial scores in PWC_{170}, reading, language and mathematics are summarized in Tables 35 to 42. No significant differences resulted for any of the dependent variables when comparing the two programs which indicates the experimental and control groups started at similar academic and fitness levels.

There was a significant difference between boys and girls pre-test PWC_{170} scores. (Table 36) Both the control and experimental boys scored higher than the corresponding girls' groups with the experimental girls possessing the lowest mean score of 394 kpm/min. (Table 33 and 34) The difference between boys and girls PWC_{170} score is not completely supported by research. Adams, Linde and Miyake (1961) and Cummings and Cumming (1963) discovered similar results to this study. However Bengtsson (1956), Rodahl, Astrand, Birkhead, Mettinger, Issekutz, Jones and Weaver (1961) and Wilmore and Sigerseth (1967) all report no differences in physical working capacity between the sexes to an age of thirteen to fifteen years.

Pre-test academic scores in this study are slightly higher than the Blanshard Project (1976) in reading and language but lower in mathematics (Table 7). however, students are starting grade six at or near the expected score of 6.0. Language was the only academic subject which revealed a significant difference between boys and girls. (Table 40) The experimental boys started the year almost ten months behind the experimental girls (boys 5.35, girls 6.32) while the control boys were nearly eight

months behind the control girls (boys 5.55, girls 6.31). (Table 39) Since this trend between the sexes occurred in both schools and there were no significant differences in language achievement between the two classes, the academic year started at similar language levels.

Analysis and Discussion of Post-test Data

Grade Three

The results of the analysis of covariance on post-test scores are tabulated in Tables 20, 23, 26 and 29. Regardless of whether the post fitness and post academic achievement results were analysed according to sex or the entire grade, the covariate remained at a significant level indicating that the pre-test scores in PWC_{170}, reading, language and mathematics were a significant factor in determining post-test scores. The fitness or academic level at which a student began the project determined to a great extent his level level of achievement at the end of the project. The covariate in all cases was the pre-test score for each dependent variable which elminated any variation on post-test scores attributable to pre-test variation.

The post-test PWC_{170} main effect showed no significant differences between experimental and control groups. The treatment factor therefore did not appear to influence the physical working capacity of students at this grade level in the experimental school.

The lack of detectable significant differences may be attributable to the wide variability of scores and the analysis being conducted on collapsed data which will mask some differences between groups.

Cote' (1979) discovered the experimental program had differential effects on various subgroups of this study. The experimental grade three group with low initial PWC_{170}/kg fitness scores significantly improved these scores in the period under investigation, while the corresponding control group remained stationary.

Cote' also indicates the experimental program had a positive influence in preventing adiposity from increasing whereas in the control school adiposity did increase in some groups of children.

Similarly, the three sub tests in academic achievement indicated no significant differences between the two groups at the end of the school year. Although the experimental school allocated four hours less time to instruction in academic subjects, test results at the end of the year indicate students in this program attained similar levels of academic achievement as students in the control school. When broken into sex comparisons between the two schools there was only one significant difference for boys post reading scores (Table 24). The control boys in grade three scored significantly higher in reading than the experimental grade three boys (Table 9). Although this result did not affect comparisons between classes, reasons for this difference cannot be explained by results from this project. In other subtest comparisons between boys and girls, the experimental and control groups achieved similar scores.

The changes in scores or growth score from initial testing in October, 1977 to the final testing in May, 1978 are summarized by class

(Table 9) and by sex and class (Tables 10 and 11 and Figures 6, 7, and 8). The grade equivalent scores in the Canadian Test of Basic Skills are based on the assumption that the average student in grade three will begin the year at 3.0 and finish the year at 4.0 with growth score of 1.0. Students in both programs of this project approximated this value (Table 9) with the control school scoring slightly higher in the three academic subjects (Figures 2, 3 and 4). These growth scores were much greater than those reported in the Blanshard Project (Table 7). Despite the decrease in time for academic instruction students in the experimental school maintained normal academic growth patterns during the period under investigation.

Grade Six

Results from the analysis of covariance for fitness and academic achievement variables are summarized in Tables 43, 46, 49 and 52. The covariate of pre-test scores remained at a significant level for all post-test analyses indicating that the pre-test scores for all variables were a significant factor in determining post-test scores. The analysis of covariance revealed a significant difference in post-test PWC_{170} results with the experimental group scoring higher than the control group (Table 32, Figures 1 and 9). Most of this difference between the two programs is attributable to the experimental girls who showed a marked increase over the duration of this project with a pre-test PWC_{170} score of 394.05 kpm/min. and a post-test score of 554.04 kpm/min. (Table 33,

Figure 1) Cote, (1979) in a study done in conjunction with this work determined there was a difference in growth rate as measured by height between the experimental and control groups with the control group being faster. Since this difference was common to both grades and sexes and since only one subgroup, grade six, revealed differences in post-test PWC_{170}, some factor other than growth rate was responsible for the recorded differences in PWC_{170} scores. The treatment factor in the experimental school apparently contributed to the dramatic increase in aerobic fitness in grade six girls.

Cote determined the experimental program had a significant, positive effect in the grade six subgroup with low initial PWC_{170}/kg fitness scores. Grade six students involved in the daily physical activity program did not change in adipose tissue whereas the control grade six students increased skinfold thickness.

Tables 44, 45, 47, 48, 50, 51, 53 and 54 summarize the analysis of post-test data for boys and girls. Only one significant main effect was evident. The experimental grade six girls scored significantly higher on post-test PWC_{170} than the control grade six girls. (Table 45) As in grade three, the grade six boys scored consistantly higher than the girls (Tables 24 and 34, Figure 9) however, this result is not completely corroborated in the research. These results may reflect certain societal values and trends where at young ages boys and girls are involved in more free play than organized sports whereas when students approach senior elementary grades boys tend to have greater involvement in organized

activities than girls. This may account for the superior performances by the boys in the fitness tests.

The analysis of covariance revealed no significant differences between the two programs for the three academic subjects. (Tables 46, 49 and 52) Students participating in daily physical education in the experimental school were able to attain similar levels of academic development as the control school students.

The academic growth scores for the experimental and control grade six classes (Table 32) are lower than expected (King, 1977) but similar to results from the Blanshard Project. (Table 7) Only the experimental group's mathematics score (0.87) and the control group's language score (0.73) approximate the expected score of 1.0. (Figure 10, 11 and 12) There is a negative change in score in reading for the control group which is atypical and difficult to explain. (Table 32, Figure 10) This may be accountable by the fact that final testing was done by the author and not the homeroom teacher which may have lowered students' incentive to do well. In addition, answer sheets were renumbered for the reading test to correspond to the numbers in the test booklet which may have confused students and caused some to locate answers incorrectly on the answer sheet.

The Blanshard Project (1976) revealed only a 0.1 growth score for reading which corresponds closely to the results in this study and which may reveal an inherent weakness in the reading subtest at the grade six level. This study cannot account for other reasons which would explain

this negative growth score.

An analysis of covariance was conducted of the final academic scores to determine if there were differences between the scores for boys in the experimental and control programs and similarly for the girls. Results indicate no significant differences exist between the boys or between the girls in the two programs. The difference in the number of instructional hours for academic subjects in the two programs had similar, non-significant effects on both the boys and girls.

The overall results in academic achievement in grade three and six substantiate the arguement that decreasing the time allocated for instruction in academic subjects need not necessarily result in a loss in academic achievement. As Lumby (1979) indicates:

> "It is important to realize that academically engaged minutes are often significantly fewer than the allotted number of minutes. Reduction of the allotted time in any one subject should not necessarily result in the loss of productive time." (p. 6)

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Results from this comparative study between an experimental daily physical education program and a control program verify the hypothesis that no significant differences in cardiovascular fitness as measured by a submaximal bicycle ergometer test occurred in grade three students exposed to the treatment factor. This may suggest that a training effect at this age is unreasonable (Schmuker & Hollmann, 1974) or that if children at this age do adapt to cardiovascular stress (Gatch & Byrd, 1979; Macek, Vaura & Novosadova, 1976) that the intensity of activity in the physical education program was not severe enough to cause a significant change. Massicotte and McNabb (1974) suggest a minimum heart rate of 170 beats per minute to improve maximal oxygen uptake in prepubertal boys.

The physical working capacity of children in grade six involved in daily physical education was significantly improved when compared to the control schools therefore causing rejection of the second hypothesis of this study. Of particular importance is the dramatic, positive effect of daily physical education in grade six girls. Research indicates that both boys and girls of this age respond to training programs. (Astrand et al., 1963; Eiseman & Goulding, 1975; Massicotte & MacNab, 1974; Schmucker & Hollmann, 1974) If habitual activity levels are low for girls at age eleven or twelve, daily physical education with similar levels of intensity as the experimental program may enhance their physical working capacity.

Results of this study verify the third hypothesis. Levels of academic achievement of students in the experimental program were not significantly different from those students in the control program despite having four hours less time devoted to academic instruction. Increasing the weekly time for physical education does not detract from the academic development of students in grades three and six.'

Recommendations

Continued quantitative and qualitative evaluation of physical education programs and fitness levels of students is needed to clarify the effects of daily physical education. A longitudinal study would not only provide details of physiological changes from year to year but also could provide details of psychological attitudes towards activity as students continue in academic institutions and enter adult life. Much more detailed observation of activity levels within physical education classes and habitual activity patterns outside the school would help to determine the nature and intensity of daily physical education programs needed to create the desired physiological changes. Continued monitoring of academic development will help to determine the optimal amount of time necessary to ensure normal, academic development. Further examination of the need for physical education specialists and effective teaching methodologies at specific grade levels is required. A comparison of two programs similar to those in this study where similarly trained teachers were responsible for the physical education programs would minimize any differences attributable to teacher training. The same test administrators should be utilized

during pre and post testing. Analysing the effects of daily physical education on academic and fitness variables in groups arranged according to academic ability would reveal possible differential effects of the treatment variable. Ultimately what is necessary are individualized assessments and programs that provide students who are experiencing problems in physical or academic domains the opportunity to enhance development by increasing the amount of productive time allocated to the problem area.

TABLES

Table 8. Means for height (cm) and weight (kg) for boys and girls.

	8 years		11 years	
	Boys	Girls	Boys	Girls
Height	129.4	128.2	146.3	148.9
n	29	28	28	24
Weight	26.7	26.1	36.7	40.1
n	29	28	28	24

Table 9. Grade 3 summary table of the mean scores and changes in scores for Pre test and Post test.

	EXPERIMENTAL			CONTROL		
	PRE	POST	Δ	PRE	POST	Δ
PWC kpm/min	331.56	373.49	41.93	342.26	369.48	27.22
READ.	3.25	4.09	0.84	3.54	4.48	0.94
LANG.	3.09	4.03	0.94	3.26	4.29	1.03
MATH.	3.00	3.87	0.87	3.28	4.18	0.90

Table 10. Grade 3 summary table of the mean scores and changes in scores for boys and girls.

	EXPERIMENTAL					
	BOYS			GIRLS		
	PRE	POST	Δ	PRE	POST	Δ
PWC kpm/ min	344.36	414.55	70.19	317.84	329.51	11.67
READ.	3.26	3.89	0.63	3.23	4.29	1.06
LANG.	2.99	3.86	0.87	3.17	4.18	1.01
MATH.	3.13	3.85	0.72	2.88	3.90	1.02

Table 11. Grade 3 summary table of the mean scores and changes in scores for boys and girls.

	CONTROL					
	BOYS			GIRLS		
	PRE	POST	Δ	PRE	POST	Δ
PWC kpm/ min	344.03	393.16	49.13	340.61	347.39	6.78
READ.	3.69	4.71	1.02	3.39	4.25	0.86
LANG.	3.29	4.19	0.90	3.24	4.41	1.17
MATH.	3.38	4.19	0.81	3.19	4.17	0.98

Table 12. Grade 3 means and standard deviations for Pre-test PWC_{170} for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	344.360	89.372	15
Experimental Girls	317.846	92.982	14
Control Boys	344.028	53.717	14
Control Girls	340.613	53.993	15

Table 13. Grade 3 summary table of the analysis of variance using pre-test PWC_{170} as the dependent variable.

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	1824.828	0.326	0.571
Boys vs Girls	1	3245.949	0.579	0.450
Interaction	1	1932.543	0.345	0.559
s within	54	5602.313		

Critical F-ratio = 4.03

Table 14. Grade 3 means and standard deviations for pre-test Reading for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	3.262	1.133	13
Experimental Girls	3.231	0.783	13
Control Boys	3.692	0.997	13
Control Girls	3.385	0.790	13

Table 15. Grade 3 summary table of the analysis of variance using pre-test Reading as the dependent variable.

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	1.111	1.264	0.267
Boys vs Girls	1	0.372	0.424	0.518
Interaction	1	0.249	0.284	0.597
s within	48	0.879		

Critical F-ratio - 4.05

Table 16. Grade 3 means and standard deviations for pre-test Language for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	2.992	0.595	13
Experimental Girls	3.171	0.691	14
Control Boys	3.285	1.122	13
Contr	3.236	0.947	11

Table 17. Grade 3 summary table of the analysis of variance using pre-test Language as the dependent variable.

Source	Degree of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	0.404	0.550	0.462
Boys vs Girls	1	0.054	0.074	0.787
Interaction	1	0.164	0.223	0.839
s within	47	0.734		

Critical F-ratio - 4.05

Table 18. Grade 3 means and standard deviations for pre-test Mathematics for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	3.131	0.736	13
Experimental Girls	2.877	0.495	13
Control Boys	3.377	0.622	13
Control Girls	3.186	0.694	14

Table 19. Grade 3 summary table of the analysis of variance using pre-test Mathematics as the dependent variable.

Source	Degree of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	1.019	2.454	0.124
Boys vs Girls	1	0.655	1.578	0.215
Interaction	1	0.013	0.031	0.861
s within	49	0.415		

Critical F-ratio - 4.04

Table 20. Grade 3 summary table of the analysis of covariance using post-test PWC_{170} as the dependent variable and pre-test PWC_{170} as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre PWC_{170}	1	57552.461	13.219	0.001 *
Main Effect	1	1085.504	0.249	0.620
Explained	2	29319.000	6.734	0.002 *
Residual	55	4353.656		
Total	57	5229.633		

Critical F-ratio = 4.02

* $p \leq .05$

Table 21. Grade 3 boys summary table of the analysis of covariance using post-test PWC_{170} as the dependent variable and pre-test PWC_{170} as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre PWC	1	26086.367	6.902	0.014 *
Main Effect	1	3270.518	0.865	0.361
Explained	2	14678.469	3.883	0.033
Residual	26	3779.757		
Total	28	4558.234		

Critical F-ratio - 4.20

* $p \leq .05$

Table 22. Grade 3 girls summary table of the analysis of covariance using post-test PWC_{170} scores as the dependent variable and pre-test PWC_{170} scores as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre PWC_{170}	1	20830.969	6.239	0.019 *
Main Effect	1	681.043	0.204	0.655
Explained	2	10756.031	3.22	0.056
Residual	26	3338.615		
Total	28	3868.431		

Critical F-ratio - 4.20

* $p \leq .05$

Table 23. Grade 3 summary table of the analysis of covariance using post-test Reading as the dependent variable and pre-test Reading as the covariate.

Source of Variation	Degrees of Freedom	Mean Squares	F Ratio	Probability
Covariate Pre Reading	1	10.510	26.209	0.000 *
Main Effect	1	0.829	2.067	0.157
Explained	2	5.669	14.138	0.000 *
Residual	49	0.401		
Total	51	0.608		

Critical F-ratio = 4.40

* $p \leq .05$

Table 24. Grade 3 boys summary table of the analysis of covariance using post-test Reading as the dependent variable and pre-test Reading as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Reading	1	6.477	13.492	0.001 *
Main Effect	1	2.591	5.397	0.029 *
Explained	2	4.534	9.445	0.001 *
Residual	23	0.480		
Total	25	0.804		

Critical F-ratio - 4.24

* $p \leq .05$

Table 25. Grade 3 girls summary table of the analysis of covariance using post-test Reading as the dependent variable and pre-test Reading as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Reading	1	4.093	14.083	0.001 *
Main Effect	1	0.093	0.319	0.578
Explained	2	2.093	7.201	0.004 *
Residual	23	0.291		
Total	25	0.435		

Critical F-ratio - 4.24

* $p \leq .05$

Table 26. Grade 3 summary table of the analysis of covariance using post-test Language as the dependent variable and pre-test Language as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Language	1	14.490	29.933	0.000 *
Main Effect	1	0.280	0	0.450
Explained	2	7.385	15.256	0.000 *
Residual	48	0.484		
Total	50	0.760		

Critical F-ratio - 4.04

* $p \leq .05$

Table 27. Grade 3 boys summary table of the analysis of covariance using post-test Language as the dependent variable and pre-test Language as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Language	1	9.690	17.681	0.001 *
Main Effect	1	0.095	0.144	0.708
Explained	2	4.892	7.412	0.003 *
Residual	23	0.662		
Total	25	0.999		

Critical F-ratio - 4.24

* p ≤ .05

Table 28. Grade 3 girls summary table of the analysis of covariance using post-test Language as the dependent variable and pre-test Language as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Language	1	4.731	14.383	0.001 *
Main Effect	1	0.233	0.708	0.409
Explained	2	2.482	7.546	0.003 *
Residual	22	0.329		
Total	24	0.508		

Critical F-ratio - 4.26

* p ≤ .05

Table 29. Grade 3 summary table of the analysis of covariance using post-test Mathematics as the dependent variable and pre-test Mathematics as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Mathematics	1	14.526	45.611	0.000 *
Main Effect	1	0.102	0.321	0.573
Explained	2	7.314	22.966	0.000 *
Residual	50	0.318		
Total	52	0.588		

Critical F-ratio - 4.02

* p < .05

Table 30. Grade 3 boys summary table of the analysis of covariance using post-test Mathematics as the dependent variable and pre-test Mathematics as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Mathematics	1	13.824	56.211	0.000 *
Main Effect	1	0.040	0.161	0.692
Explained	2	6.932	28.186	0.000 *
Residual	23	0.276		
Total	25	0.781		

Critical F-ratio - 4.24

* p ≤ .05

Table 31. Grade 3 girls summary table of the analysis of covariance using post-test Mathematics as the dependent variable and pre-test Mathematics as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Mathematics	1	2.864	8.504	0.008 *
Main Effect	1	0.079	0.235	0.632
Explained	2	1.472	4.370	0.024 *
Residual	24	0.337		
Total	26	0.424		

Critical F-ratio - 4.23

* p ≤ .05

Table 32. Grade 6 summary table of the mean scores and changes in scores for Pre test and Post test results.

	EXPERIMENTAL			CONTROL		
	PRE	POST	Δ	PRE	POST	Δ
PWC kpm/ min	459.49	566.39	106.40	501.90	535.62	33.72
READ.	6.27	6.51	0.24	6.35	6.22	- 0.13
LANG.	5.87	6.51	0.54	5.85	6.58	0.73
MATH.	6.10	6.97	0.87	6.12	6.76	0.64

Table 33. Grade 6 summary table of the mean scores and changes in scores for boys and girls.

EXPERIMENTAL

	BOYS			GIRLS		
	PRE	POST	Δ	PRE	POST	Δ
PWC kpm/ min	536.06	580.65	44.59	394.05	554.04	159.99
READ.	5.96	6.19	0.23	6.56	6.81	0.25
LANG.	5.34	5.70	0.36	6.32	7.03	0.71
MATH.	5.85	6.74	0.89	6.34	7.19	0.85

Table 34. Grade 6 summary table of the mean scores and changes in scores for boys and girls.

CONTROL

	BOYS			GIRLS		
	PRE	POST	Δ	PRE	POST	Δ
PWC	549.41	578.34	28.93	422.71	464.42	41.71
READ.	6.12	6.04	- 0.08	6.64	6.45	- 0.19
LANG.	5.55	6.28	0.73	6.31	7.06	0.75
MATH.	5.93	6.76	0.83	6.38	6.75	0.37

Table 35. Grade 6 means and standard deviations for pre-test PWC_{170} for each school and sex.

	Means	Std. Dev.	n
Experimental Boys	536.061	82.485	13
Experimental Girls	394.053	100.091	15
Control Boys	549.407	115.353	15
Control Girls	422.711	81.987	9

Table 36. Grade 6 summary table of the analysis of variance using pre-test PWC_{170} as the dependant variable.

Source	Degree of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	5489.820	0.570	0.454
Boys vs Girls	1	224670.313	23.345	0.001 *
Interaction	1	729.694	0.076	0.784
s within	48	9623.813		

Critical F-ratio - 4.05

* $p \leq .05$

Table 37. Grade 6 means and standard deviations for pre-test Reading for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	5.957	1.230	14
Experimental Girls	6.560	1.178	15
Control Boys	6.121	1.718	14
Control Girls	6.636	0.959	11

Table 38. Grade 6 summary table of the analysis of variance using pre-test Reading as the dependent variable.

Source	Degree of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	0.193	0.111	0.740
Boys vs Girls	1	4.159	2.399	0.128
Interaction	1	0.026	0.015	0.904
s within	50	1.734		

Critical F-ratio - 4.04

Table 39. Grade 6 means and standard deviations for pre-test Language for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	5.346	0.753	13
Experimental Girls	6.320	1.231	15
Control Boys	5.550	1.344	14
Control Girls	6.311	0.790	9

Table 40. Grade 6 summary table of the analysis of variance using pre-test Language as the dependent variable.

Source	Degree of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	0.117	0.097	0.757
Boys vs Girls	1	9.230	7.678	0.008 *
Interaction	1	0.139	0.115	0.736
s within	47	1.202		

Critical F-ratio - 4.05

* $p \leq .05$

Table 41. Grade 6 means and standard deviations for pre-test Mathematics for each school and sex.

	Mean	Std. Dev.	n
Experimental Boys	5.854	0.710	13
Experimental Girls	6.336	1.414	14
Control Boys	5.929	0.970	14
Control Girls	6.380	0.758	10

Table 42. Grade 6 summary table of the analysis of variance using pre-test Mathematics as the dependent variable.

Source	Degrees of Freedom	Mean Squares	F Ratio	Probability
Experimental vs Control	1	0.044	0.042	0.838
Boys vs Girls	1	2.724	2.589	0.114
Interaction	1	0.003	0.003	0.960
s within	47	1.052		

Critical F-ratio - 4.05

Table 43. Grade 6 summary table of the analysis of covariance using post-test PWC_{170} as the dependent variable and pre-test PWC_{170} as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre PWC_{170}	1	321471.625	32.937	0.000 *
Main Effect	1	46250.875	4.739	0.034 *
Explained	2	183861.250	18.838	0.000 *
Residual	49	9760.188		
Total	51	16587.680		

Critical F-ratio - 4.04

* $p \leq .05$

Table 44. Grade 6 boys summary table of the analysis of covariance using post-test PWC_{170} as the dependent variable and pre-test PWC_{170} as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre PWC_{170}	1	80165.063	9.987	0.004 *
Main Effect	1	643.500	0.080	0.779
Explained	2	40404.281	5.033	0.015 *
Residual	25	8027.293		
Total	27	10425.590		

Critical F-ratio - 4.21

* $p \leq .05$

Table 45. Grade 6 girls summary table of the analysis of covariance using post-test PWC_{170} as the dependent variable and pre-test PWC_{170} as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre PWC_{170}	1	259796.688	31.451	0.000 *
Main Effect	1	86267.063	10.444	0.004 *
Explained	2	173031.875	20.947	0.000 *
Residual	21	8260.313		
Total	23	22508.273		

Critical F-ratio - 4.28

* $p \leq .05$

Table 46. Grade 6 summary table of the analysis of covariance using post-test Reading as the dependant variable and pre-test Reading as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Reading	1	21.025	23.020	0.000 *
Main Effect	1	1.418	1.553	0.218
Explained	2	11.222	12.286	0.000 *
Residual	51	0.913		
Total	53	1.[illegible]		

Critical F-ratio - 4.03

* $p \leq .05$

Table 47. Grade 6 boys summary table of the analysis of covariance using post-test Reading as the dependent variable and pre-test Reading as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Reading	1	5.910	4.519	0.044 *
Main Effect	1	0.268	0.205	0.655
Explained	2	3.089	2.362	0.115
Residual	25	1.308		
Total	27	1.440		

Critical F-ratio = 4.21

* $p \leq .05$

Table 48. Grade 6 girls summary table of the analysis of covariance using post-test Reading as the independent variable and pre-test Reading as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Reading	1	15.639	37.956	0.000 *
Main Effect	1	1.108	2.690	0.115
Explained	2	8.374	20.323	0.000 *
Residual	23	0.412		
Total	25	1.049		

Critical F-ratio = 4.24

* $p \leq .05$

Table 49. Grade 6 summary table of the analysis of covariance using post-test Language as the dependent variable and pre-test Language as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Language	1	57.116	143.631	0.000 *
Main Effect	1	0.441	1.109	0.297
Explained	2	28.779	72.370	0.000 *
Residual		0.398		
Total		1.533		

Critical F-ratio = 4.04

$p \leq .05$

Table 50. Grade 6 boys summary table of the analysis of covariance using post-test Language as the dependent variable and pre-test Language as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Language	1	28.335	86.339	0.000 *
Main Effect	1	0.994	3.032	0.094
Explained	2	14.665	44.716	0.000 *
Residual	24	0.328		
Total	26	1.431		

Critical F-ratio - 4.23 *

p < .05

Table 51. Grade 6 girls summary table of the analysis of covariance using post-test Language as the dependent variable and pre-test Language as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Language	1	16.273	36.428	0.000 *
Main Effect	1	0.005	0.011	0.918
Explained	2	8.139	18.219	0.000 *
Residual	21	0.447		
Total	23	1.116		

Critical F-ratio - 4.28

p < .05

Table 52. Grade 6 summary table of the analysis of covariance using post-test Mathematics as the dependent variable and pre-test Mathematics as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Mathematics	1	23.767	50.348	0.000 *
Main Effect	1	0.619	1.312	0.258
Explained	2	12.193	25.830	0.000 *
Residual	48	0.472		
Total	50	0.941		

Critical F-ratio = 4.40

* $p \leq .05$

Table 53. Grade 6 boys summary table of the analysis of covariance using post-test Mathematics as the dependent variable and pre-test Mathematics as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Mathematics	1	6.204	14.124	0.001 *
Main Effect	1	0.002	0.005	0.945
Explained	2	3.103	7.064	0.004 *
Residual	24	0.439		
Total	26	0.644		

Critical F-ratio - 4.23

* p ≤ .05

Table 54. Grade 6 girls summary table of the analysis of covariance using post-test Mathematics as the dependent variable and pre-test Mathematics as the covariate.

Source of Variation	Degrees of Freedom	Mean Square	F Ratio	Probability
Covariate Pre Mathematics	1	17.091	32.284	0.000 *
Main Effect	1	1.281	2.419	0.135
Explained	2	9.186	17.352	0.000 *
Residual	21	0.529		
Total	23	1.282		

Critical F-ratio - 4.26

* p ≤ .05

FIGURES

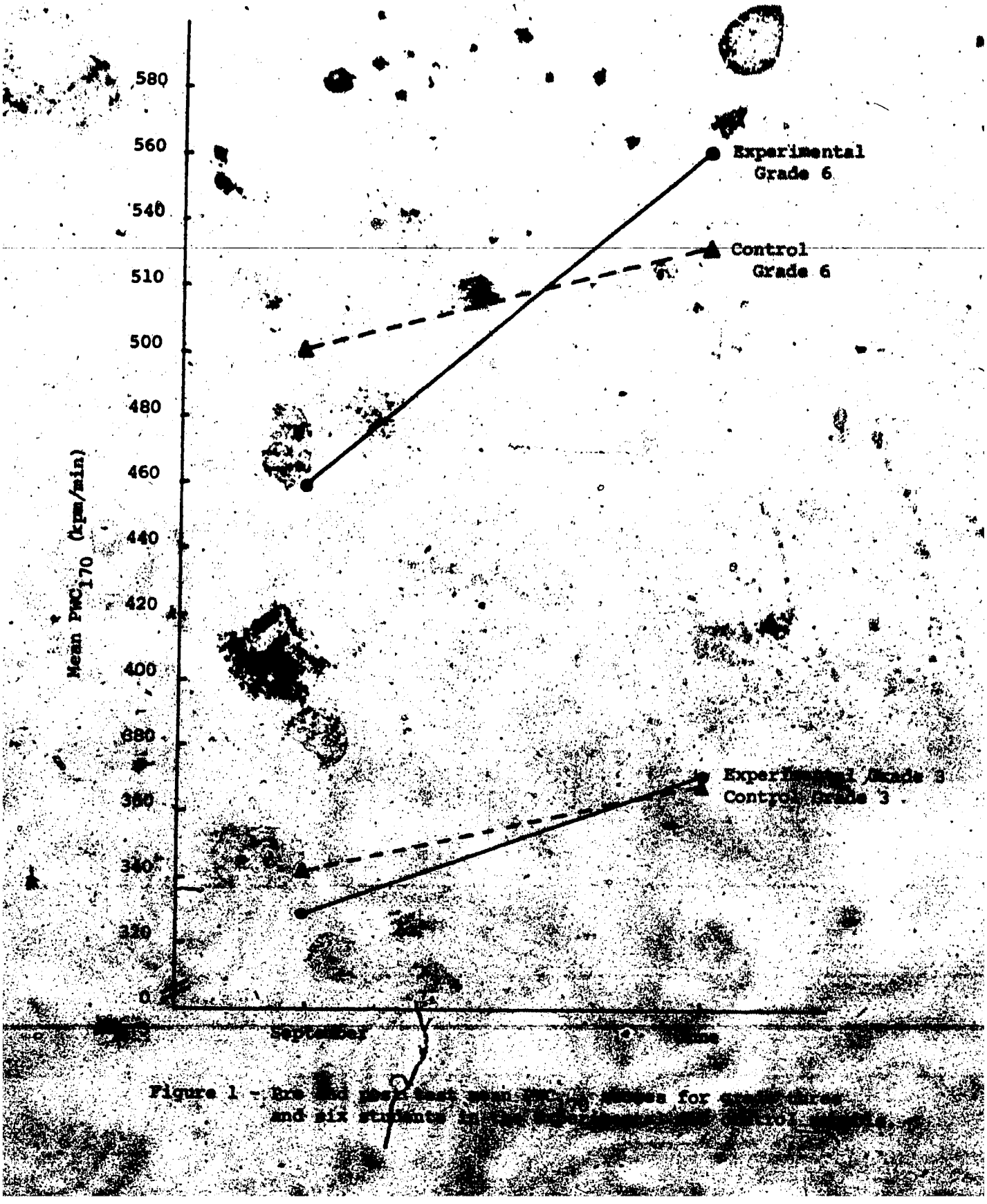

Figure 1 - [illegible] and post-test mean PWC 170 values for [illegible] and six students in the [illegible]

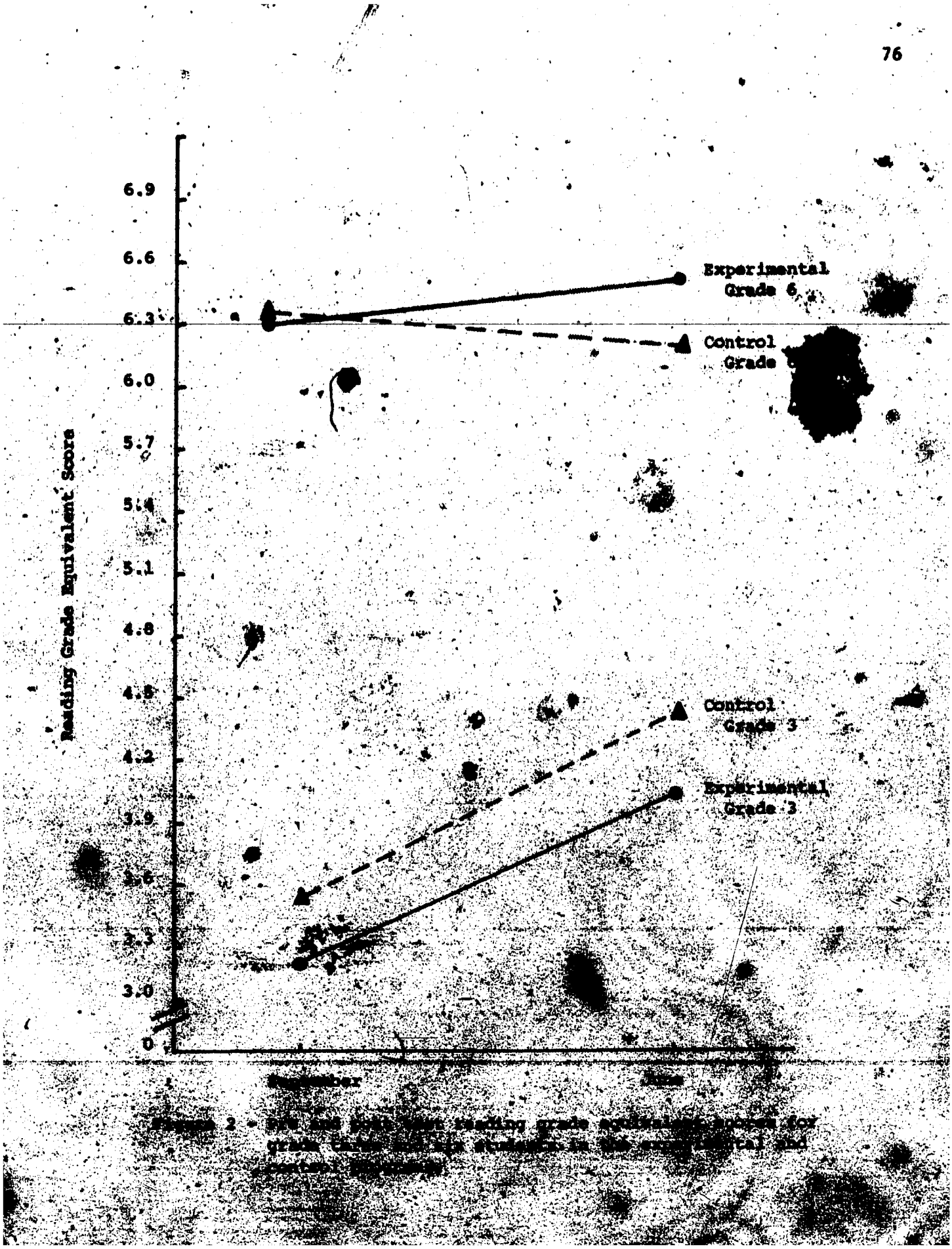

Figure 2 - Pre and post test reading grade equivalent scores for grade three and six students in the experimental and control groups

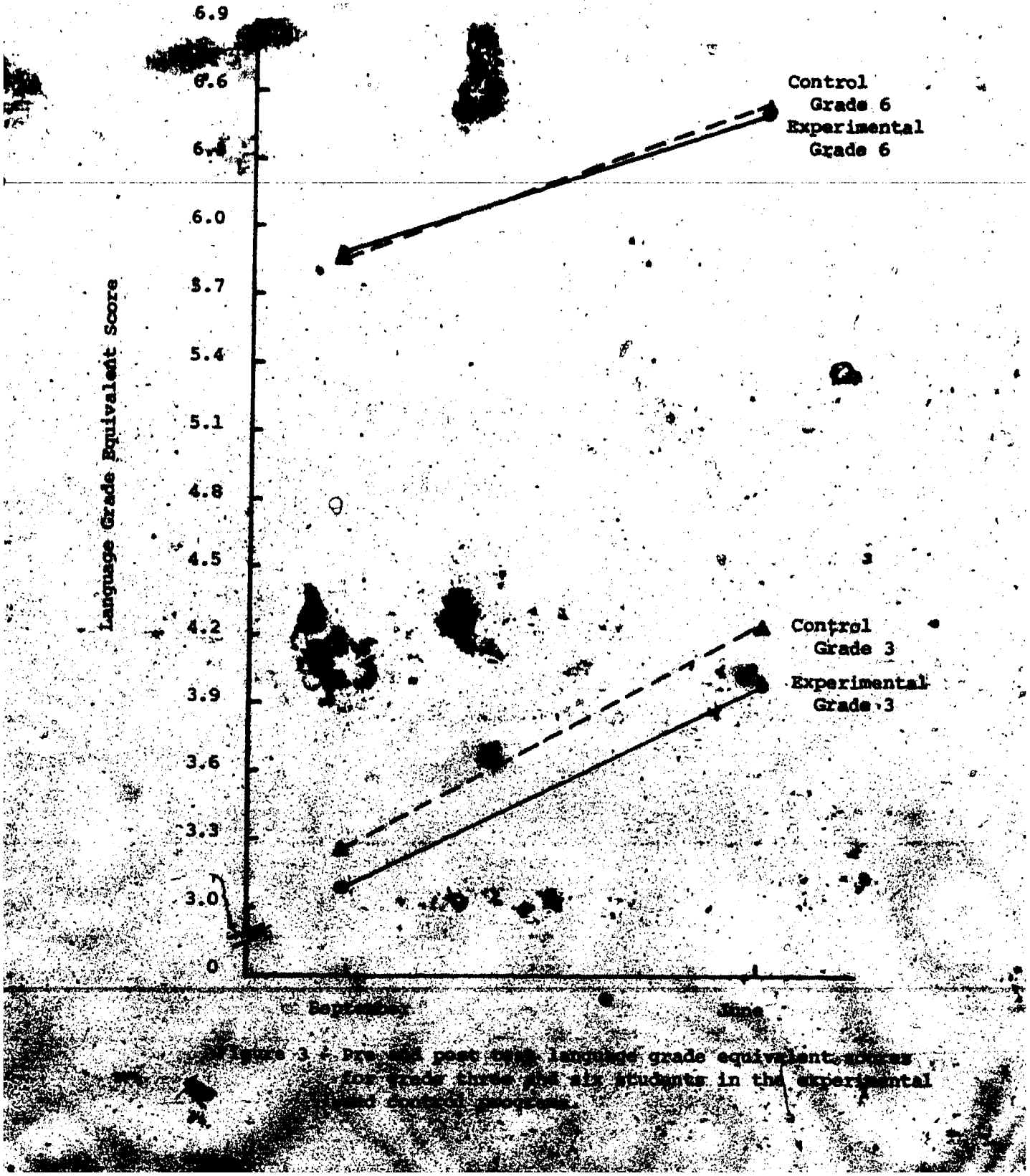

Figure 3 - Pre- and post-test language grade equivalent scores for grade three and six students in the experimental [illegible] program.

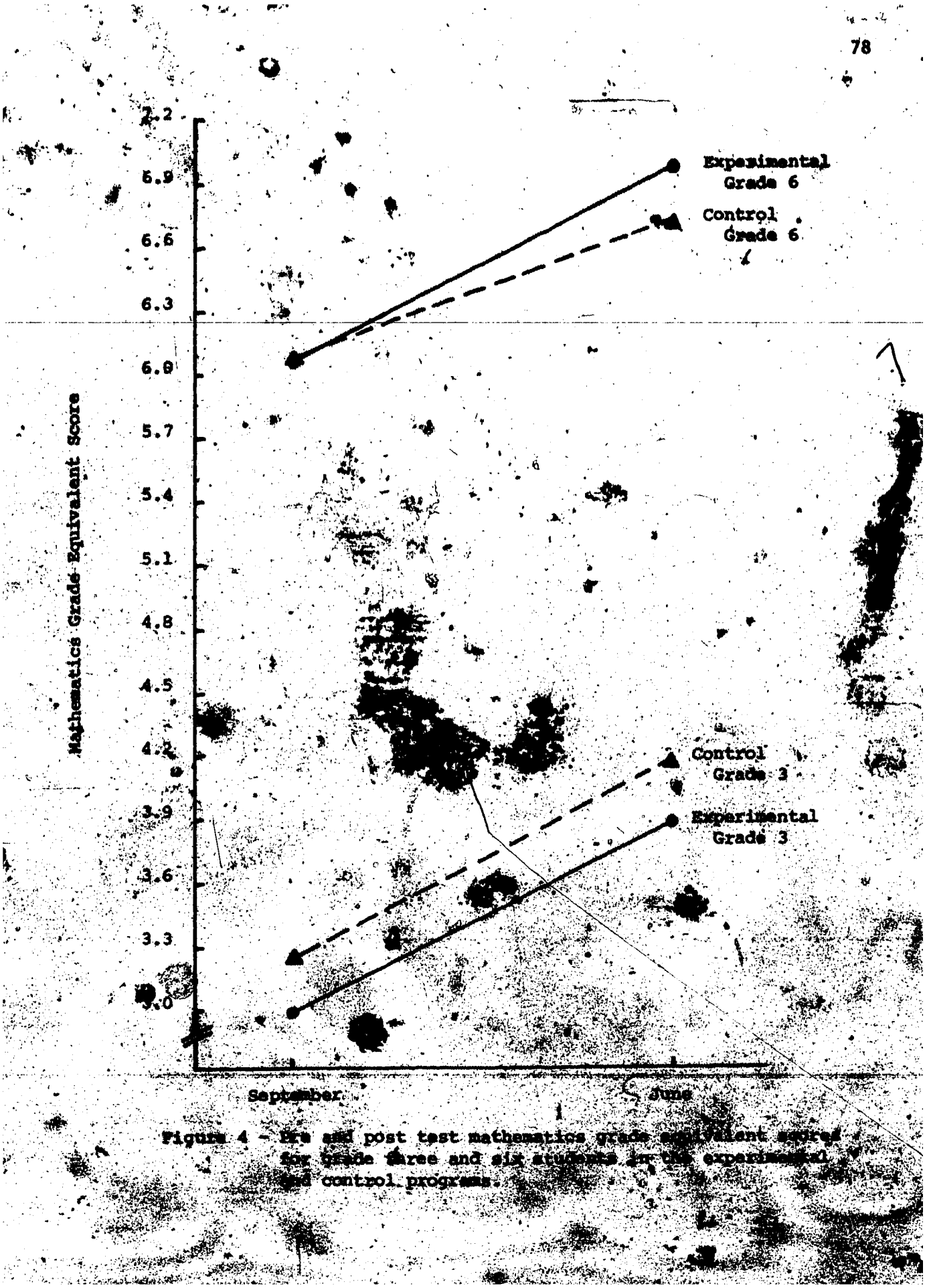

Figure 4 - Pre and post test mathematics grade equivalent scores for grade three and six students in the experimental and control programs.

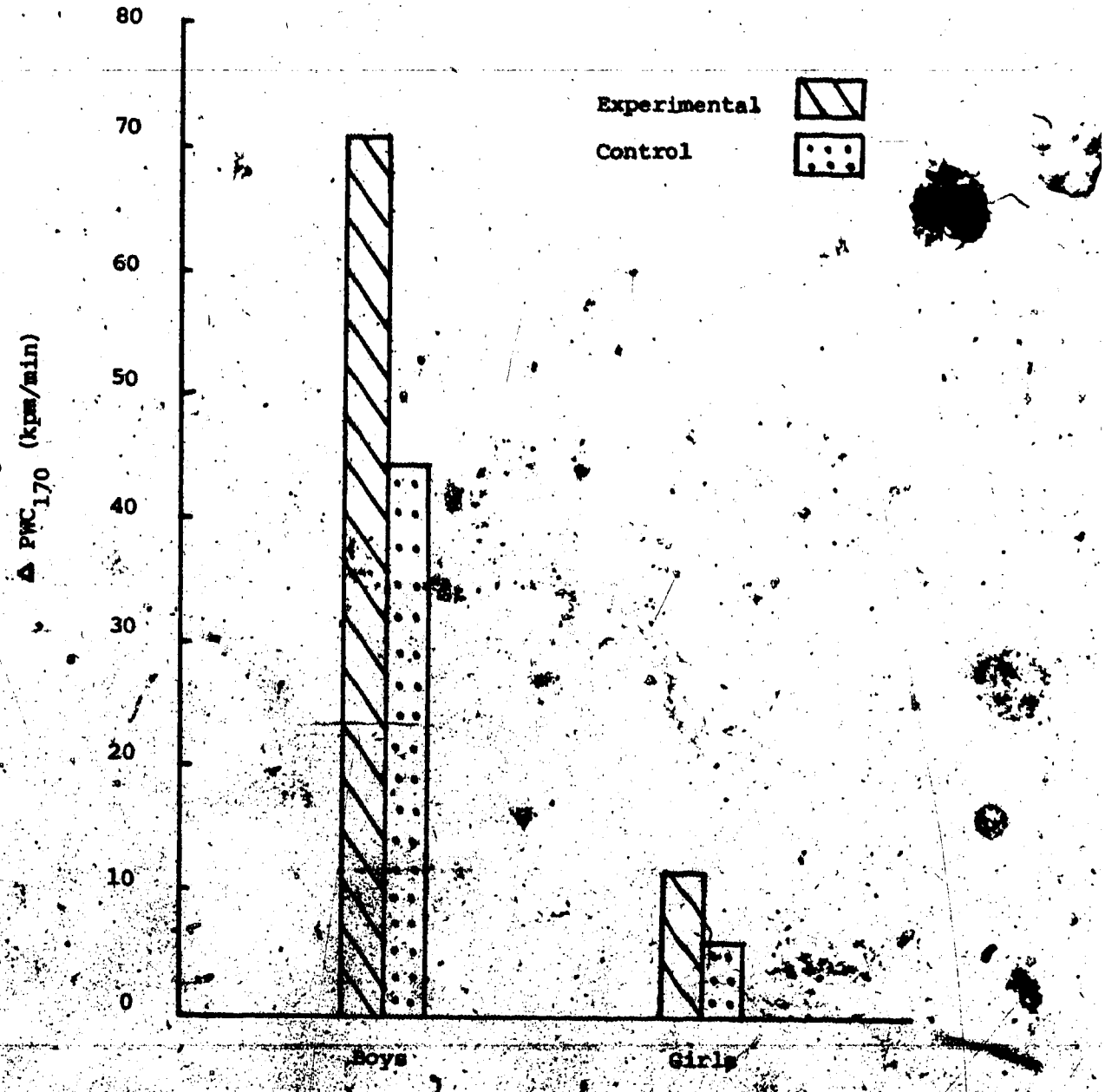

Figure 5 - Change in mean PWC_{170} scores for grade three students from September to June.

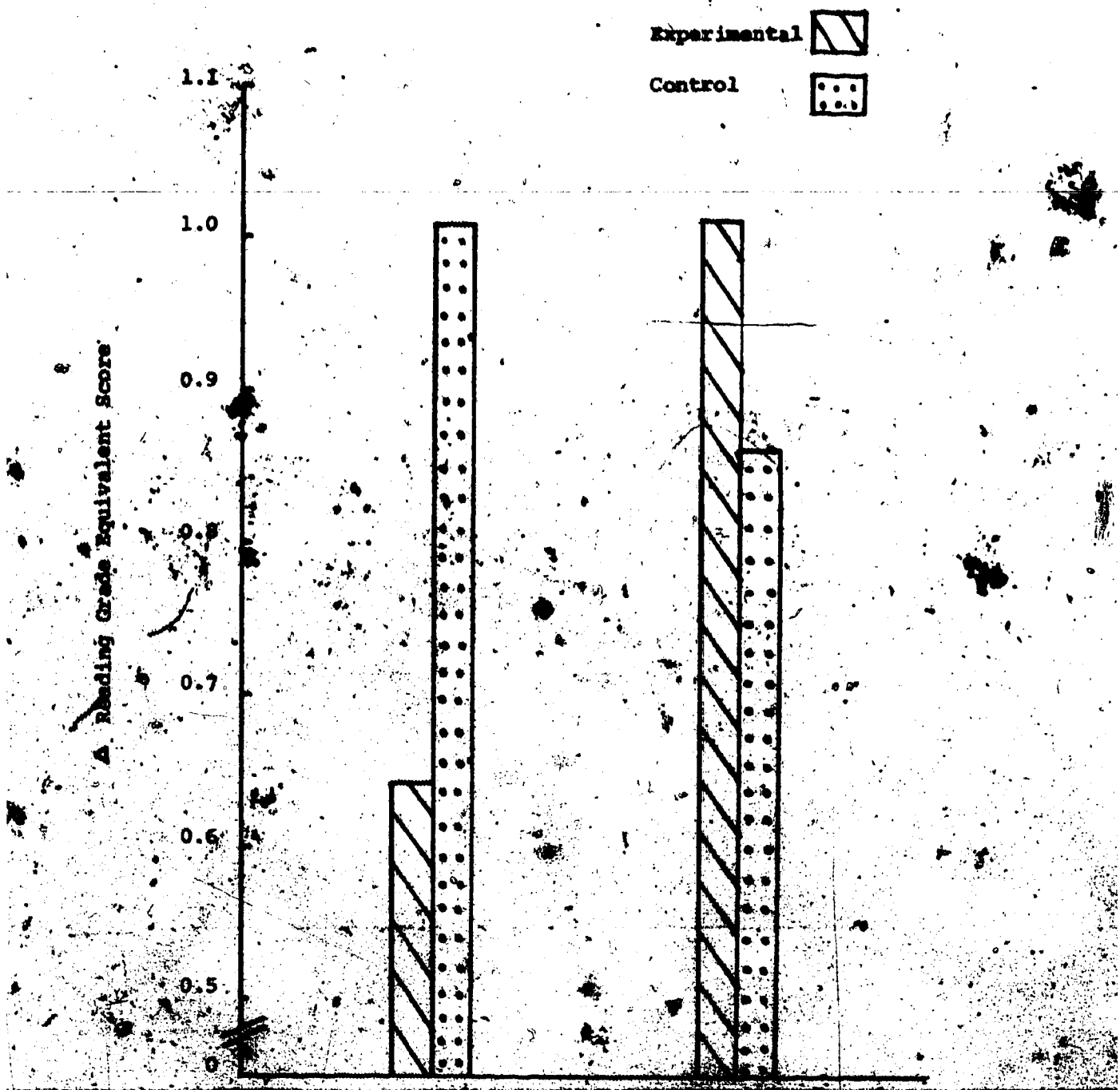

Figure 6 - Change in reading grade equivalent scores for grade three student from September to June.

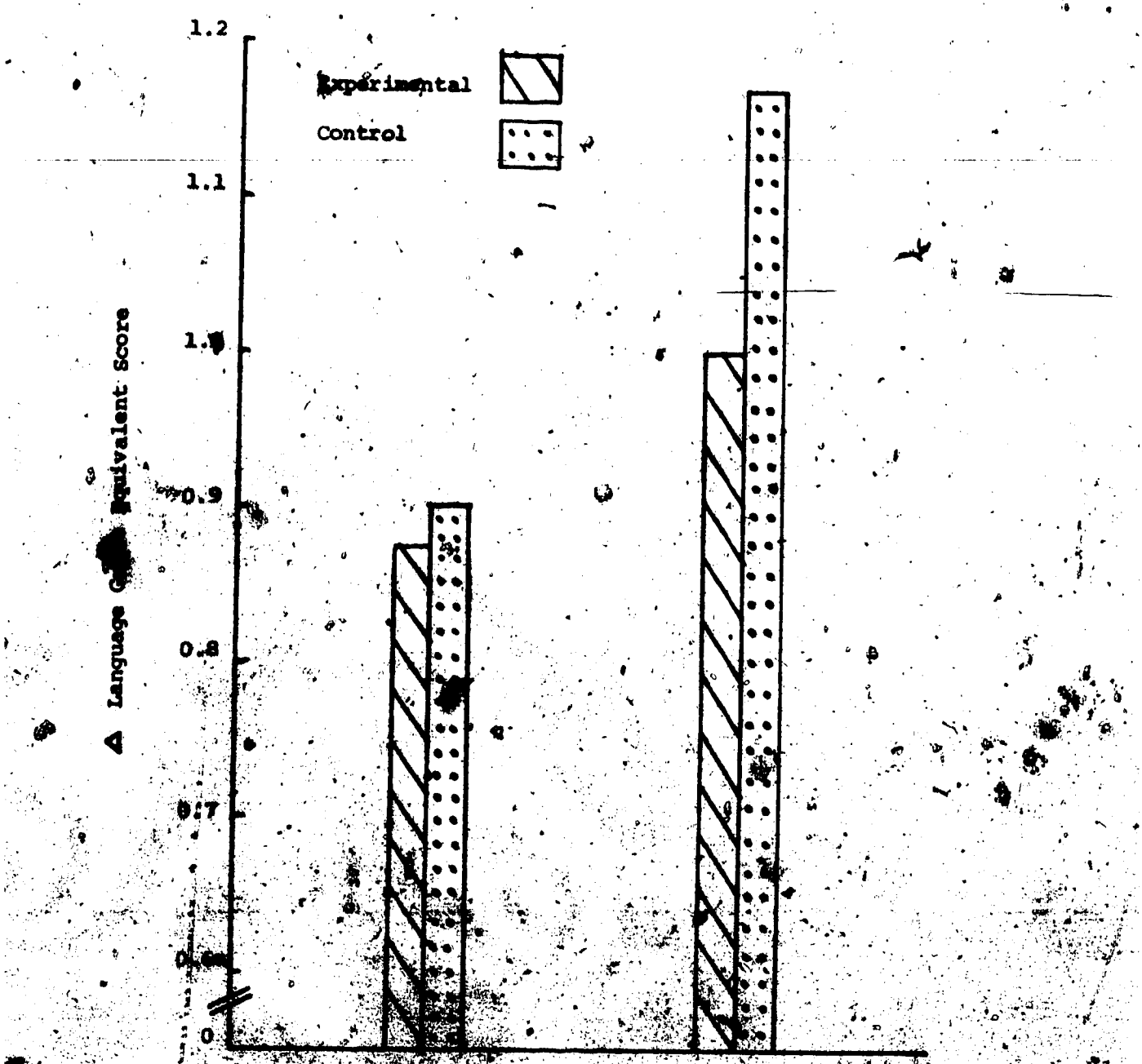

Figure 7 - Change in language grade equivalent scores for [illegible] students from September to June.

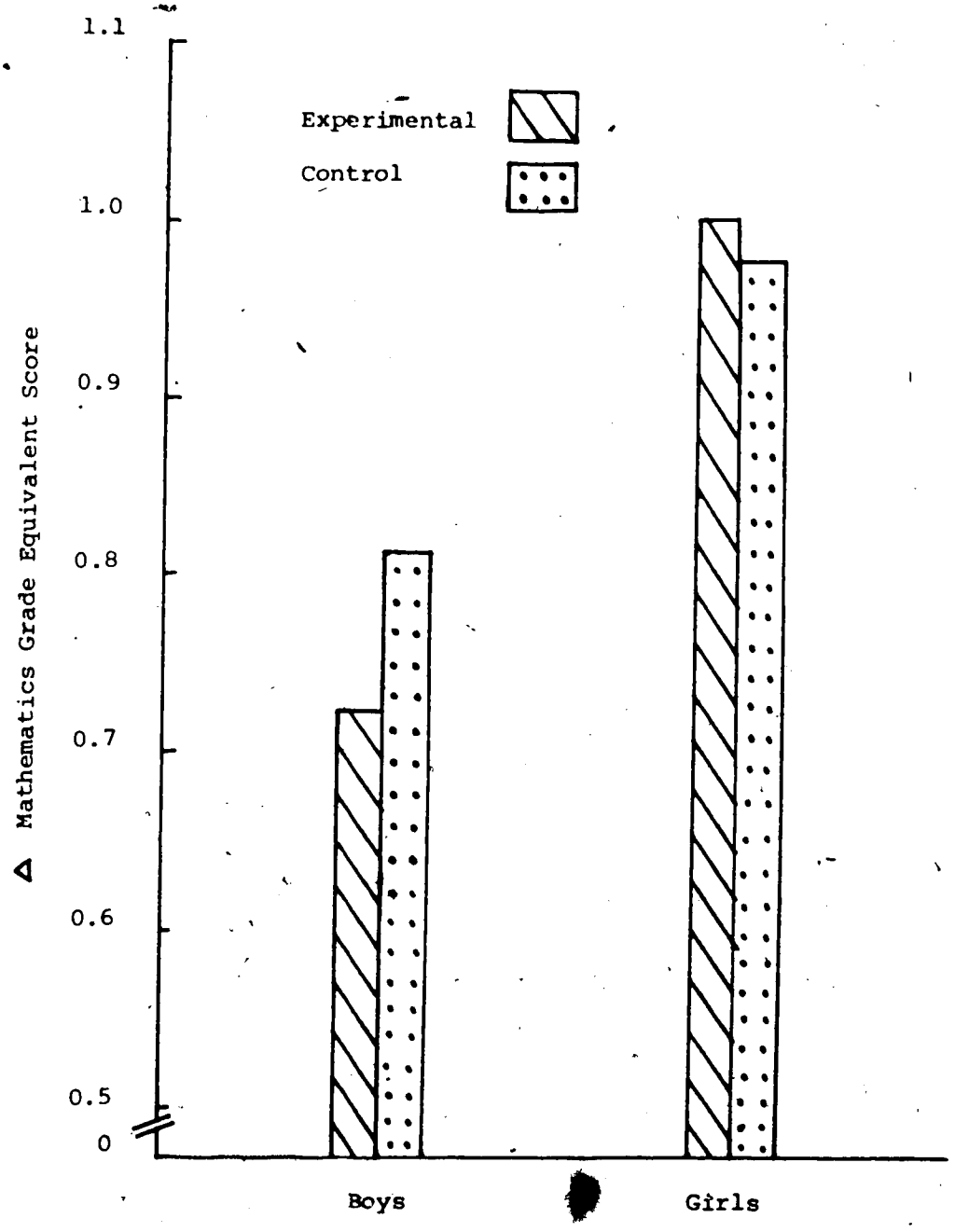

Figure 8 - Change in mathematics grade equivalent scores for grade three students from September to June.

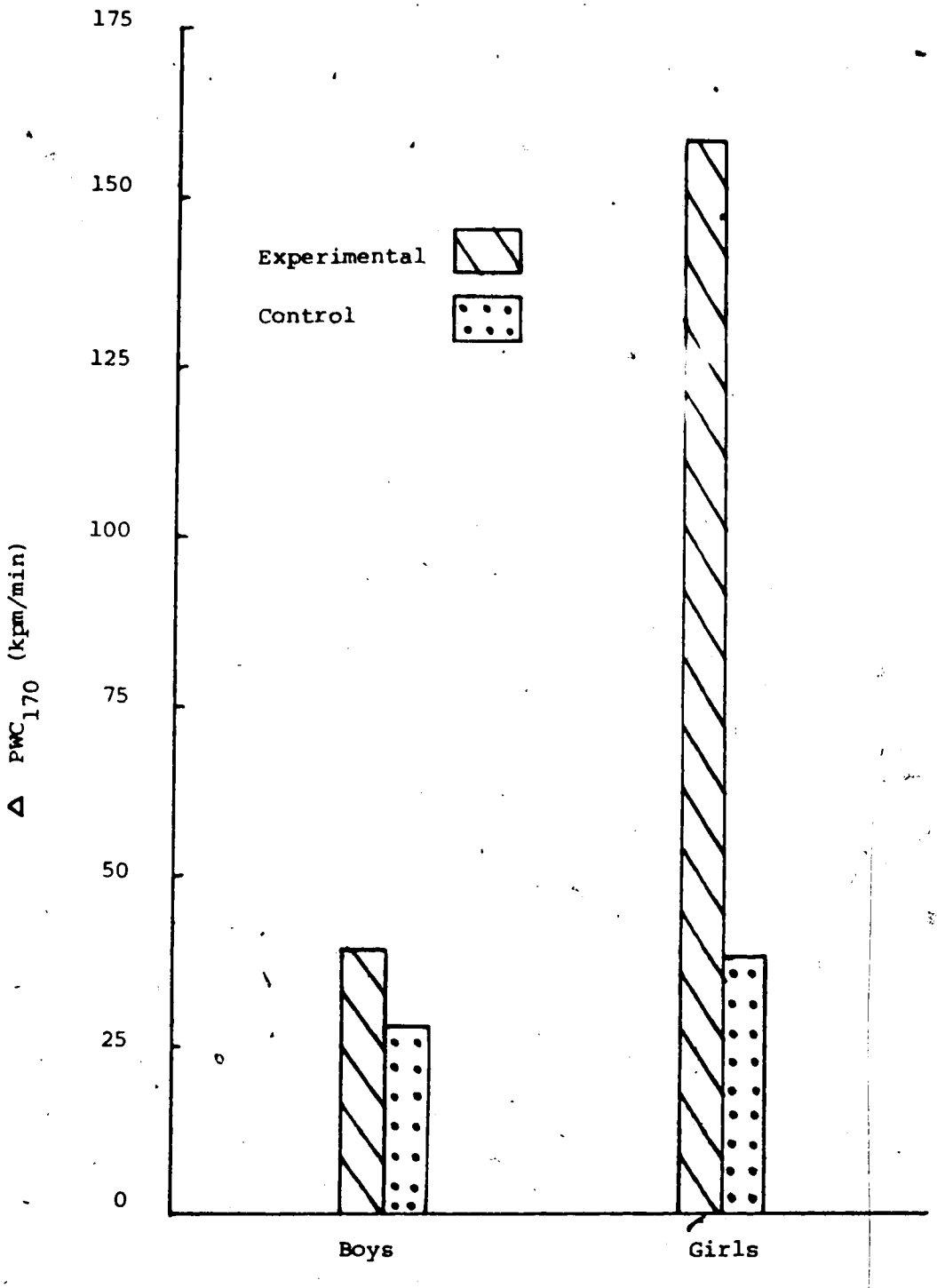

Figure 9 - Change in mean PWC_{170} scores from grade six students from September to June.

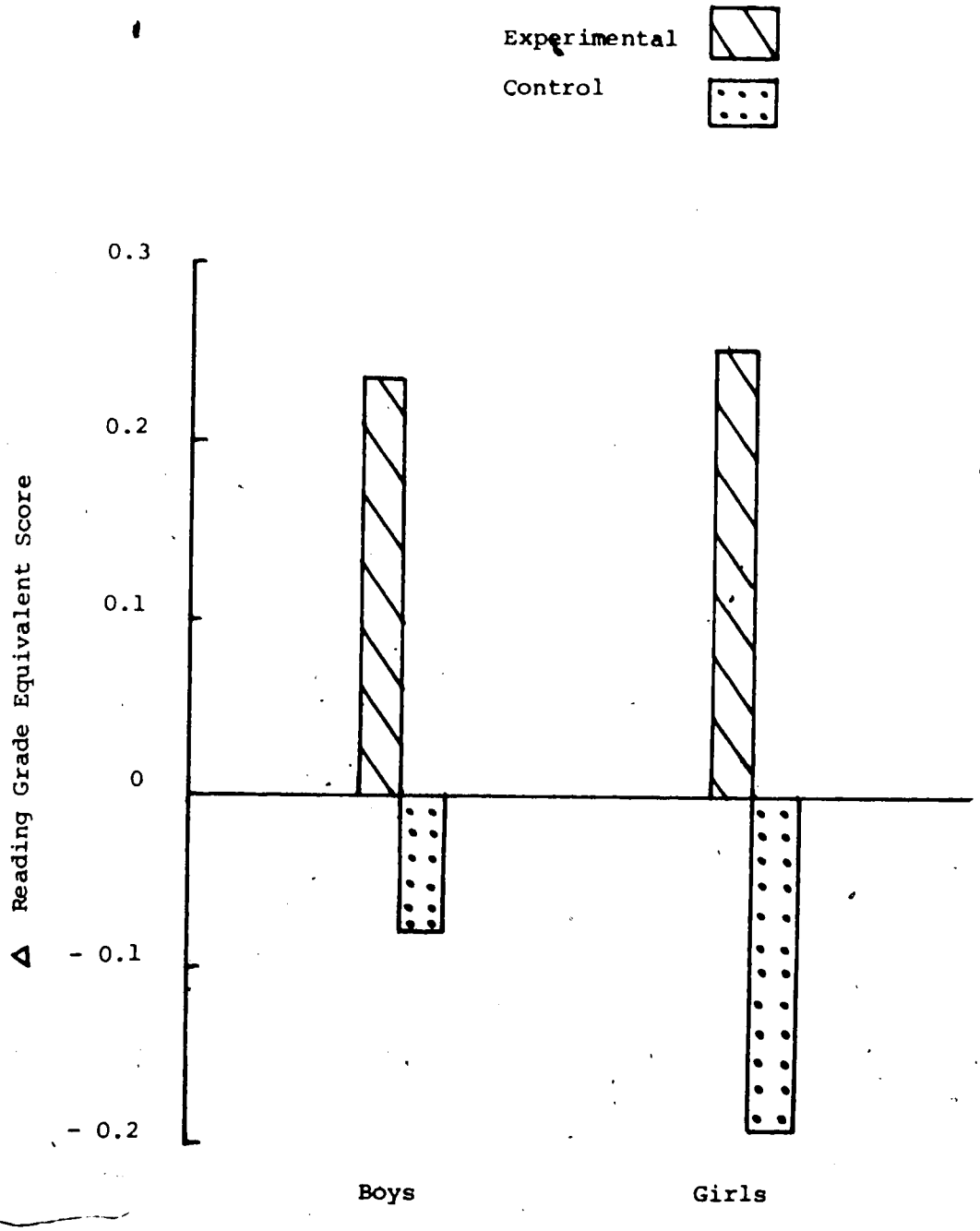

Figure 10 - Change in reading grade equivalent scores for grade six students from September to June.

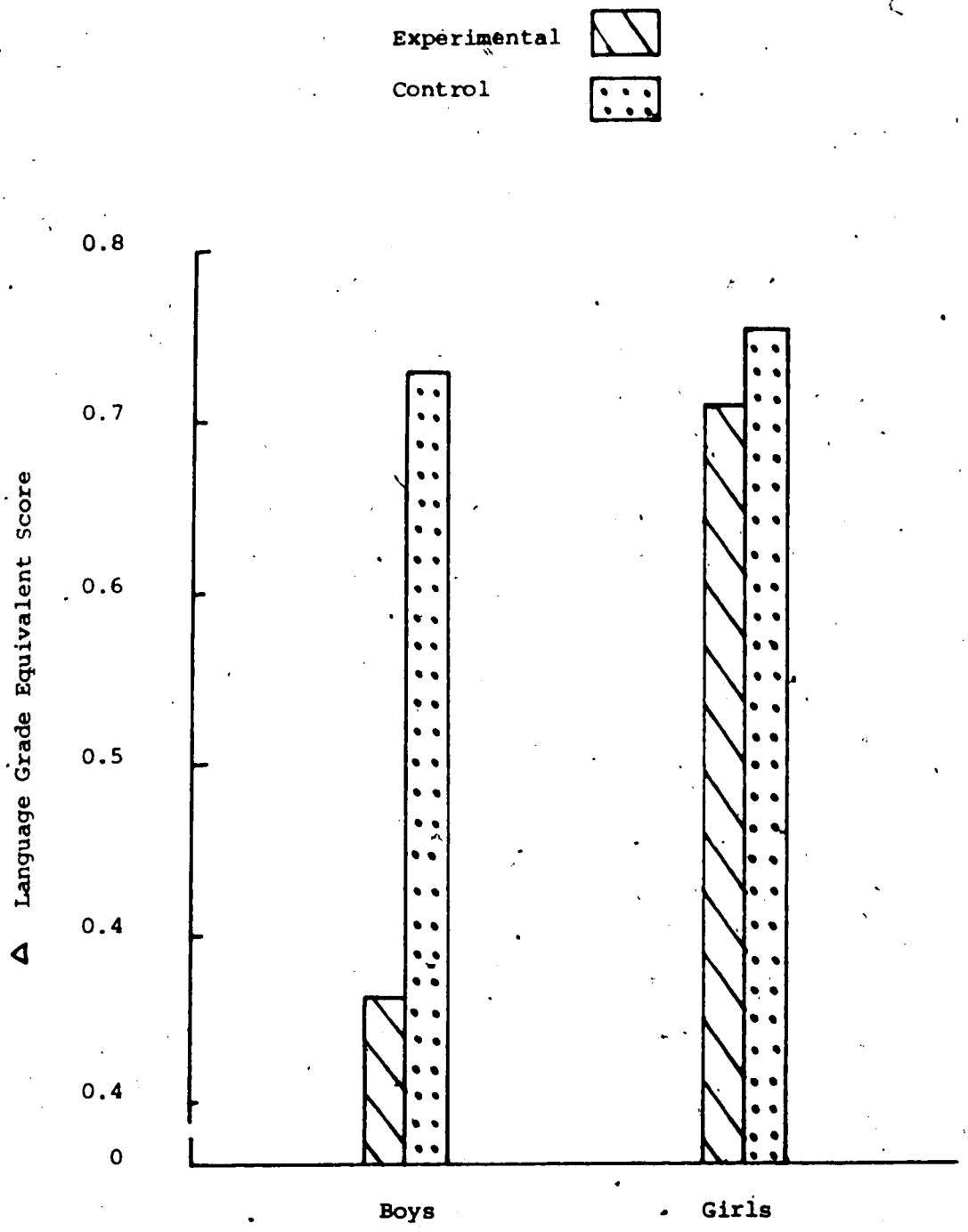

Figure 11 - Change in language grade equivalent scores for grade six students from September to June.

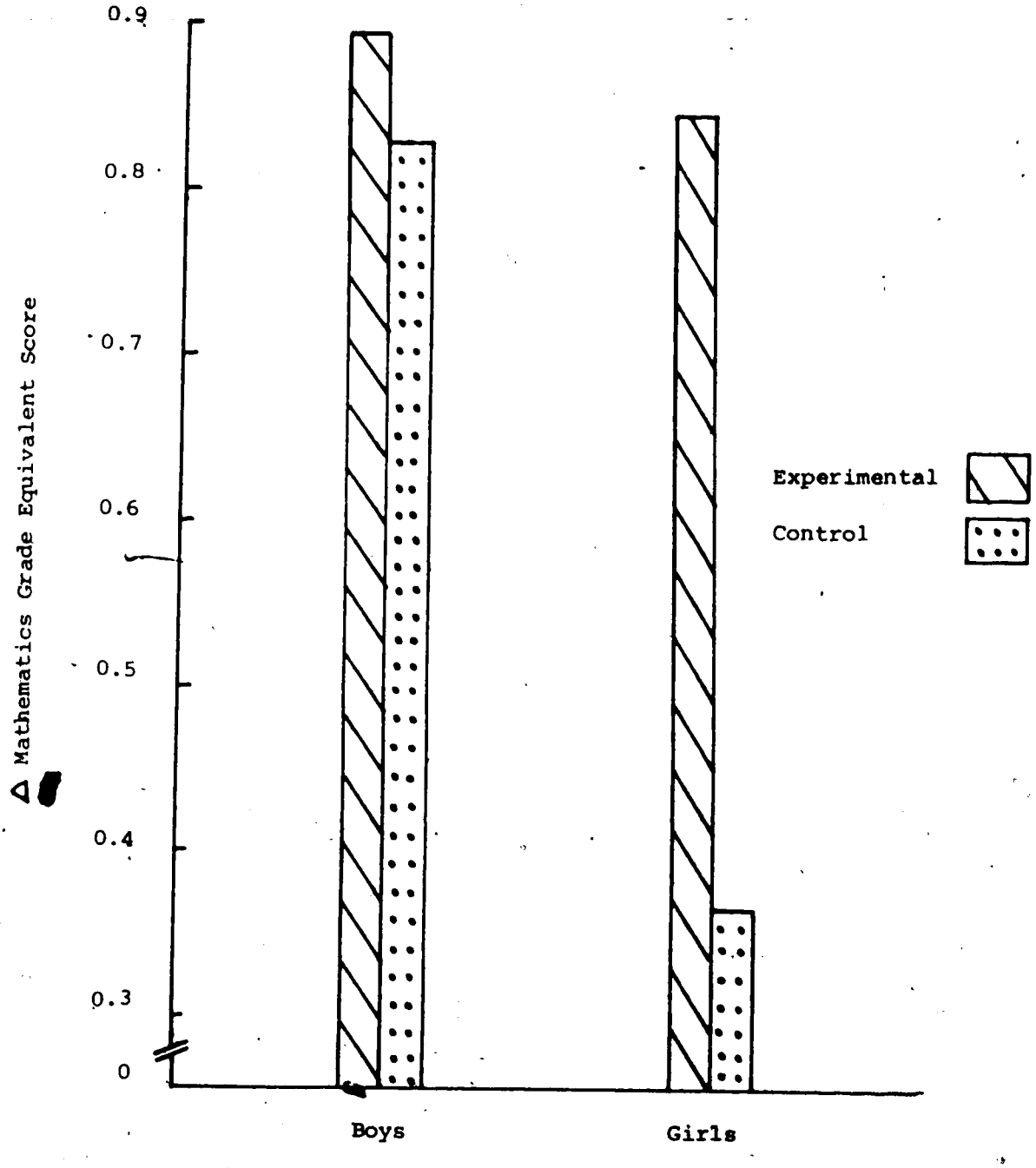

Figure 12 - Change in mathematics grade equivalent scores for grade six students from September to June.

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APPENDIX I

TEACHER ACTIVITY INVENTORY

Appendix I Teacher Activity Inventory Rick Bell 4321020

Teacher _____ Grade _____ School _____

Sept.				1	2
	5	6	7	8	9
	12	13	14	15	16
	19	20	21	22	23
	26	27	28	29	30
Oct.	3	4	5	6	7
	10	11	12	13	14
	17	18	19	20	21
	24	25	26	27	28
Nov.	30	1	2	3	4
	7	8	9	10	11
	14	15	16	17	18
	21	22	23	24	25
Dec	28	29	30	1	2

APPENDIX II

REVISED TEACHER OBSERVATION INSTRUMENT

Teacher Structuring

1. Physical education centred behavior

   i.e. today we are going to work on travelling

   - does not elicit response

   - explaining principles

2. Non physical education behavior

   - any actions done by teacher not related to class

Teacher Soliciting

(elicit responses)

3. Command, Authoritarian Directive

   - one response possible, stand up!

4. Limiting or restricting Directive

   i.e. show a balance on hands and feet

5. Open or free Directive

   - many responses open

6. Teacher Questioning

   - question about content or procedure with answer by students either verbal or action

Teacher Reacting Behavior

7. Teacher confirming Performance Reactions

   - relates to activities responses

8. Teacher confirming Behavior Reactions

   - relates to behavior responses

9. Teacher correcting (rejecting) Performance Reactions

   i.e. children not right, I asked for 2 B.P.

10. Teacher correcting Behavior Reaction
    i.e. class pay attention!
11. Teacher extending Reactions
    - wants further variety
12. Teacher focussing Reactions
    - wants quality
13. Demonstration