CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

THE EFFECT OF KNOWLEDGE OF SCIENTIFIC PRINCIPLES ON RUNNING A MAZE

A thesis submitted in partial satisfaction of the requirements for the degree of Master of Arts in Physical Education

by

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ABSTRACT

THE EFFECT OF KNOWLEDGE OF SCIENTIFIC PRINCIPLES ON RUNNING A MAZE

by

Wayne Robert Keith

Master of Arts in Physical Education

June, 1973

One hundred fifteen seventh grade students from Millikan Junior High School were subjects from three physical education classes for the purpose of investigating the effect of the knowledge of scientific principles on the running of a maze.

It was hypothesized that a knowledge of scientific principles of motion would not affect the learning process of the gross motor skill of running a maze. The study was conducted in a period of three days. All of the students were pre-tested on a twenty-five yard run and then each of the three physical education classes were randomly selected for the treatment. The classes were designated Group I (principles only), Group II (principles applied
specifically to the maze), and Group III (control). On the first day each group received a different lecture and then ran the maze. The groups later completed four additional trials on subsequent days.

The analysis of variance technique was used to determine if any significant differences occurred between the groups or within the groups on the trials. The hypothesis that a knowledge of scientific principles of motion would not affect the learning process in the gross motor skill of running a maze was rejected for Trial 1 but was accepted for trials two through five.
CHAPTER I

INTRODUCTION

Man's pleasure, recreation, and labor involve physical movements in which the individual seems to indicate little concern, yet, the satisfaction of his needs and wants is dependent upon his mobility. Physical education is one discipline which has been instrumental in making man aware of his physical being. However, the responsibility of making man aware of himself is not solely the task of the physical educator.

Modern communications and technology have greatly influenced the direction of our society. Curriculum changes have been necessary to meet these societal demands. Educators are continuously probing for innovative methods and materials. In the analysis and synthesis of the new data it is not unusual for the results to encompass several subject-matter fields. As a result, one current trend in curriculum construction is to correlate subject matter. Nixon and Jewett (4:51) state, "As far as physical education is concerned, it is obvious that there are many ways
in which this subject-matter field can be correlated with other subjects in the curriculum." The physical educator must be alert to and cognizant of these opportunities.

THE PROBLEM

Statement of the Problem

Physical education is concerned with the physical development of the individual in his social milieu. One aim of physical education is efficiency in human movement. The degree of the efficiency of an individual is dependent on many variables, some of which are: his goals, attitudes, kinesthetic perception, motor abilities, mental capacities, and perhaps his exposure to principles of efficiency in movement.

The problem which initiated this study was that while several studies have been conducted in this area, the results are conflicting. A knowledge of principles as they apply to the movement processes should provide: (1) understanding and efficiency in learning; (2) proficiency in the movement skill; and, (3) a means for sustaining proficiency. Yet, the literature does not completely support this concept.
Statement of the Purpose

It was the purpose of this study to analyze the scientific principles of motion in the running of a maze and to determine whether prior knowledge of these principles would result in improved performance in the motor skill of running this maze.

Hypothesis

It was predicted that: a knowledge of scientific principles of motion would not affect the learning process in the gross motor skill of running a maze.

Design of the Study

A seventy-yard maze (Figure 1, p. 26) consisting of circles, lines and angles was constructed. An analysis of the maze was made to determine which scientific principles were involved in efficiently running the maze. One hundred fifteen seventh grade students of Millikan Junior High School in Los Angeles were randomly divided into three groups and were taught (1) abstract principles, (2) principles and their application to the maze, (3) irrelevant material. The groups were then tested on their ability to run the maze.
Limitations

The limitations of this study were: (1) The accuracy of the scores was limited by the method employed (hand-held stopwatch); (2) The quality of participation in running the maze was dependent upon the integrity of the student and his promise to 'do his best'; (3) The un-controlled variability in environmental conditions on various testing days; and (4) The fact that the subjects were not randomly assigned to the groups.

Assumptions

The assumptions of this study were: (1) Seventh grade subjects would be able to understand the scientific principles as demonstrated; (2) Students in each of the three physical education classes were of equal motor abilities; and (3) The maze constructed for this study is a valid, reliable, and objective measure of this gross motor skill.

Definition of Terms

Base of support - the area enclosed both within and between the supporting structures of an object (in this study, the subject's feet).

Center of gravity - refers to the center of weight of the body or the point at which the weight of the body is
concentrated.

**Direction** - refers to the principle of a body remaining in motion in its original direction unless acted upon by some external force.

**Inertia** - a body at rest or in motion remains at rest or in motion unless acted upon by some external force.

**Lean** - refers to the principle of overcoming centrifugal force as a body initiates a turn.

**Speed** - refers to an individual's ability to adapt his speed in lieu of the changes of direction suggested by the maze.

**Subject** - refers to the seventh grade students from Millikan Junior High School who completed the five time trials.

**Importance of the Study**

Change for the sake of change has little significance. Change based upon supportive evidence is of necessity. It is this writer's belief that scientific principles should not be utilized solely in the science and mathematics curriculum. Since efficiency in movement is one goal of physical education, teachers of this subject should have a knowledge of scientific principles and their application to efficient physical movement.
In the interest of physical education, this writer believes that few, if any, scientific principles are taught to physical education classes. Quick, reactive movements are characteristic of many sports, games and activities. It would seem from the point of view of efficiency in movement that instruction involving the scientific principles related to these movements would be superior to permitting the student to learn solely from trial and error or by experimentation.

Other educational benefits would seem to arise by utilizing scientific principles. The principles provide the individual with an understanding of 'why' he must do certain things. Time may be gained for other purposes. Motivation for, and interest in, other and more difficult types of activities may result from the study of principles.

Although the running of the maze is simple in nature, it does provide an opportunity to study principles of motion relative to sudden and quick turns which are common to many sport skills. An efficient runner reflects a knowledge of scientific principles. He may not be able to verbalize the principles, but he will be able to illustrate evidence of their application.
Organization of the Chapters

A review of the related literature will be presented in Chapter II. Chapter III will describe the procedure used in gathering the data. The results of the gathered data will be discussed in Chapter IV. Chapter V provides a summary, conclusions, and recommendations for further study.
CHAPTER II

REVIEW OF LITERATURE

Thought is often given to the evaluation of and improvement of techniques of instruction and curriculum. At times it is necessary to utilize accepted procedures from different subject areas and integrate the methods into related fields. An example of this is the extensive use of scientific methods in research.

Physical education is extensively involved with movement. Since the physical educator is so involved with movement, it seems pragmatic to incorporate within his education a knowledge of scientific principles related to movement. Most literature in the physical education field suggests that a knowledge of scientific principles of motion should enable the physical educator to:

(1) improve the performance level of the student;

(2) improve and maintain a high interest level of his students;

(3) provide for additional opportunities and activities related to physical education classes by economizing time;
(4) provide an understanding of the 'why' of movement activities;
(5) provide for efficiency in movement; and
(6) stimulate intellectual curiosity.

Effects of Knowledge of Scientific Principles on Instructionally Related Variables

Performance

Judd's (5) classic experiment supports the contention that knowledge of principles improves the performance level of the subject. Two groups of boys practiced throwing darts at a target placed twelve inches below the surface of the water. One group was given instruction in the principle of light refraction. No apparent differences were found within the performances of the groups. However, when the target was raised to a level of four inches underwater, the group with a knowledge of the refraction principle adapted more readily to the situation. Furthermore, it should be reported that the principles group was allotted additional time for receiving instruction. Also, Judd did not supply a statistical analysis of his early experiment.

Hendrikson and Schroeder (10) substantiated Judd's theory in a similar study of the refraction principle.
Ninety eighth grade boys were assigned equally to three groups. The conditions and requirements of the study were the same for the control group as they were for the two experimental groups except for the explanation of the refraction principle. The two experimental groups received the same instruction except for one additional sentence implying the deeper the object was in the water the farther apart the real object is from the image. From a distance of eight feet, the subjects fired BB-shot at standard rifle targets which were submerged in water first at a distance of six inches and then two inches. Both experimental groups learned more rapidly than the control group. It was concluded that theoretical information was of aid not only in transfer from one situation to another, but also in making the original adjustment to the initial situation.

The aforementioned studies refer to the transfer of learning of principles to applied situations. Another point of view is the instruction of subjects with scientific principles directly related to the physical activity. This should facilitate the learning of the specific motor skill.

In a study of five classes of junior high school
girls, Broer (6) wanted to determine whether teaching of sport activities could be made more effective if preceded by instruction in a general basic skills curriculum which emphasized problem solving and understanding of simplified mechanics. Her subjects were instructed in seasonal sports of volleyball, basketball, and softball, since these were the major activities of the physical education program. At the end of the specific unit, skills tests were given. She concluded the experimental group surpassed the total control group on all eight sport skills tests. The specifics of these tests were not reported.

In a similar study Mohr and Barrett (12) exposed students to simplified mechanical principles involved in the performance of the front crawl, back crawl, side and elementary backstrokes. The subjects of this study were thirty-four women enrolled in two intermediate swimming classes at the University of Maryland. The lessons were identical except for the use of the mechanical principles in explaining the correct performance of each stroke to the experimental group.

During eight weeks of instruction the experimental group made significantly greater improvement in all strokes but the elementary backstrokes. It is the opinion
of the writer that this could have been due to the se-
quence of the instruction, the elementary backstroke it-
self, or the innate abilities of the individuals.

Farley (13) utilized a mechanical device (not dis-
closed by Farley in this source) as well as scientific
principles to determine their value for improving per-
formance in shooting a one-handed shot in basketball. His
subjects were 129 seventh grade boys in four physical
education classes. The control group received no instruc-
tions relative to the scientific principles or to the
mechanical device. One experimental group was subjected
only to the mechanical device. Two of the experimental
groups received instruction based upon a scientific prin-
ciple relative to parabolic trajectory. One of these
groups also utilized a mechanical device. After seven
weeks he concluded,

Instruction of basketball shooting that makes
specific reference to desirable angles of
projection, angles of entry, and the relative
margin for error at the time of entry will
significantly increase junior high boys angles
of projection with or without the use of the
mechanical device (13).

No reference was given as to the effect of the
mechanical device nor the shooting percentage.

All evidence does not support the theory of knowledge
of scientific principles enhancing the learning of motor
skills. Graves (14) in a study of 624 boys in second,
fourth and sixth grades wanted to determine if elementary
school boys could apply the principles of projection, ac-
celeration and foot force to the ball throw for distance.
Each class was subdivided into four groups. One control
group received an initial and a final test, the ball throw
for distance. Another control group received only the
final test. One experimental group received an initial
test, a period of instruction concerning the three princi-
bles, and a final throw test. A second experimental group
received only instruction and a final test. It was re-
ported that performance in the ball throw for distance
improved significantly by the second and sixth graders
following instruction and that they also applied the pro-
jection principle to a significant degree. However,
knowledge of the foot force and acceleration principles
were of no significance in this study for any of the
elementary grade levels. The knowledge of the projection
principle did not prove significant for the fourth grade
levels.

In another study, Meyer (17) analyzed methods of
teaching the motor skill of bowling where one approach
employed the mechanical principles of the movement (not specified by Meyer) as compared to the traditional approach to the teaching of the skill. His subjects were fifty-eight male college freshmen enrolled in the required physical education classes. The two classes met for two seventy-five minute periods per week for nine weeks. He concluded that the mechanical principles approach to teaching the motor skill of bowling is not significantly better than the traditional approach. However, he stated that those who knew more about mechanical principles of movement make greater improvement in bowling skill.

A study by Coleville (8) reflects the same general expression as Meyer's investigation of methods. Three principles of mechanics and three skills associated with the principles were used. These were: (1) angles of incidence and reflections - rolling a ball to rebound from a surface; (2) opposing forces of momentum - catching a tennis ball with a lacrosse stick and a badminton bird with a tennis racquet; and (3) aerial forces of momentum and gravity - archery. The subjects of this investigation were 118 undergraduate women students from the University of Southern California. For each of the experiments the subjects were divided equally and spent equal time either
in practicing the skill itself or learning about the principle. It was found that there was no evidence that one method was superior to the other method. It was also reported that there was no evidence that knowledge facilitates subsequent learning as evidenced in the performance of a similar or more complicated skill to which the principle is applicable.

Burack and Moos (7) attempted to discover whether familiarity with the basic principle underlying the solution to the problem necessarily leads to the solution of the problem. Three groups of eight students randomly selected from an elementary psychology class from Roosevelt College were the subjects of this study. Each group was to solve a mechanical puzzle based upon the principle of centrifugal force. The object was to manipulate the puzzle such that two metal balls would rest on two ledges, one at each end. If the puzzle was not solved after a time span of one and one-half minutes, each group received additional instruction. One group received verbal examples of the basic principle, a second group received a demonstrational example of the basic principle, and the third group received a series of hints progressing from the abstract to the concrete ideas basic to the principle.
None of the students were able to solve the problem. It was concluded that an awareness of neither the general principle nor examples of it will necessarily enable the subject to apply this information to a new problem based on that principle.

Interest

The integration of scientific or mechanical principles with physical education would seem to develop a greater desire to learn. Knowing how and why to achieve is important to developing and maintaining a high level of interest.

At the community of Eagle Grove, Iowa, Pace and Lau (11) developed a unit entitled 'Basic Scientific Understanding of Physical Activity'. Their prime concern was to assist the student in understanding the 'why' of movement skills. The students were confronted with scientific terms and principles involved in movement. At the conclusion of the unit the instructors made the following observations:

The students showed greater appreciation and satisfaction when performing physical skills because of a clearer understanding of the complexities of the activities involved. The students showed a greater willingness to improve on skills by devoting more time to skill drills (11:23).
Inasmuch as Broer's study was an investigation of principles related to skill, she observed,

When given problems to solve, the groups worked diligently and evidenced a desire to share their conclusions with members of other groups. Discussion was lively and rarely was it necessary for the investigator to bring out specific methods or reasons for them (6:388).

A sub-problem of Imel's (16) study was a student's evaluation of programmed units involving scientific principles related to skill activities. It was reported that the majority of the students believed that the material was valuable as a study aid and was enjoyable to use.

**Economy of Time**

Time is of essence to everyone. Does the integration of scientific principles interfere with the time schedule of the physical education class? None of the studies this writer examined indicated that this would be the case. Also, none of the studies involving the scientific principles approach indicated that the results were less significant than the traditional methods of approach.

Broer (6) reported a definite economizing of time in her investigation. In the principles approach of instruction she used one-third as much time in volleyball, two-thirds as much time in basketball, and an equal amount
of time as in softball. Yet, the experimental group exceeded the control group in all skills tests.

The subjects of Coleville's investigation did not differ in attaining skill as compared to the principles approach and the traditional approach. However, Coleville stated,

Since it appears that some part of the learning period may be devoted to instruction concerning general principles without detriment to the motor learning of the students, it would seem desirable to include such instruction in order to provide this additional opportunity for acquiring some related knowledge about principles of mechanics and application of forces (8:326).

SUMMARY

The investigations are conflicting as to the effectiveness of the principles method of teaching motor skill versus the traditional approach. Judd (5) and Hendrikson and Schroeder (8) reported that knowledge of the refraction principle was beneficial in throwing darts and rifle shooting at underwater targets. Broer (6) purported success in teaching mechanical principles related to sport activities in a junior high school. Mohr and Barrett (12) found that performance was enhanced by exposing the subjects to simplified mechanical principles related to the front crawl, back crawl, side and elementary backstrokes.
Farley (13) reported that knowledge of the principle of parabolic trajectory would significantly improve the angle of projection in basketball shooting for junior high school boys.

In a study of elementary school boys, Graves (14) found that a knowledge of the foot force and acceleration principles was not significant in a ball throw for distance. Meyer (17) reported that the basic mechanical principles approach to teaching bowling was not significantly better than the traditional approach. Coleville (8) purports that instruction concerned with principles related to the performance of the skill did not facilitate the learning of the skill any more than that of practicing the skill. Burack and Moos (7) found that an awareness of neither the general principle nor examples of it will necessarily enable the subject to apply the information to different problems based on that principle. Imel (16) developed four instructional units of principles programmed for supplementary use in physical education classes. Three of the four units of principles did not significantly increase the learning process.

The author feels that the apparent conflict in the literature may be explained by the complexity of the
of the principle related to the skill and to the intellectual development of the student. Even though the principles are explained to the student, the understanding and application of them may be beyond his level of comprehension, or he may already be aware of them and thus does not benefit from the instruction. For this reason, the present study uses junior high school students rather than college students.

In most of the studies the investigation did not involve a time factor. The one study (6) that did report a time factor indicated a favorable reaction to instruction of principles because in two of three instructional periods time was definitely economized.

From the point of view of maintaining a high level of interest or creating interest by use of principles in the physical education curriculum only three studies (6, 11, 16) reported comments about interest. All of the studies reported favorable reactions by the subjects.
CHAPTER III

METHODS

The purpose of this investigation was to determine the effectiveness of knowledge of scientific principles on subjects running a seventy-yard maze. Included in this chapter is a discussion of the subjects, the grouping of the subjects, the general design of the study, the testing procedure, the demonstration procedure, the experiment itself, and the statistical design.

Selection of the Subjects

All five seventh grade physical education classes from Millikan Junior High School were initially selected for this study. However, because one class did not meet daily, and another was too small, they were eliminated from the study.

Since the nature of the investigation involved an equal control of conditions, those subjects who were not present on the scheduled day of activity were not permitted to 'make up' the test. Some subjects were
eliminated because of injury while participating in the time trials. As a result, 115 subjects completed the entire experiment.

**Grouping of the Subjects**

The three physical education classes were randomly assigned to the following treatments: (1) Group I - principles only; (2) Group II - principles applied specifically to the maze; and (3) Group III - control.

**Pilot Study**

In the spring semester of 1972 at Millikan Junior High School four groups of five subjects each participated in a pilot study. The purpose of the pilot study was to determine the feasibility and practicality of an investigation relative to the effect of applying scientific principles to running a maze. One result of the pilot study was a modification in the length of the maze. A second result was that the explanation of the scientific principles was reworded to conform to a level which seemed more applicable to seventh grade students.
General Design

Each subject in the main study was given a pre-test which consisted of a twenty-five yard run. Following this pre-test, Group I was given a demonstration and a lecture on abstract scientific principles (Appendix A) which are utilized in the running of the maze. After completion of the lecture on principles, the subjects were given post-test 1. Post-test 1 consisted of one trial run of the maze.

Group II was given a demonstration and a lecture (Appendix B) on the scientific principles and their specific application to the maze. After completion of the lecture on applied principles, the subjects were given post-test 1.

Group III was given a lecture (Appendix C) on an unrelated topic which was approximately equal in time to the demonstration-lecture of the preceding groups. After the unrelated lecture was given, post-test 1 was administered.

Because of the large number of subjects, it was necessary to split each group and administer the post-test to half the group on each of two subsequent days. Thus, half of each group received a review of their respective
lecture and then completed post-test 2 on the second day, while the other half of each group received this treatment on the third day. Post-test 2 consisted of four additional runs of the maze.

Test Procedure

Each subject was given a pre-test in the twenty-five yard run on an asphalt surface. From a standing position each subject was given the command - Ready - Go. The starter's hand dropped. The timer started the stopwatch at the drop of the hand. When the subject passed the twenty-five yard mark the time trial was completed. The timer read the stopwatch to the nearest tenth of a second and recorded the result. The next subject then commenced the test.

The post-test consisted of trial runs of the maze. The subjects started from a standing position. He received the command - Ready - Go. The timer started the stopwatch at the drop of the hand. When the subject crossed the finish line, the trial was complete. The time was read to the nearest tenth of a second and recorded.

Each subject ran the maze in the regular physical education uniform of shorts, shirt, and tennis shoes.
Weather conditions were sunny the days of the twenty-five yard run and post-test 1 and cloudy for the completion of post-test 2.

After completion of the first trial run of post-test 2, the subject left the area of the maze. While under the supervision of his regular physical education teacher, he was instructed to contemplate on how to efficiently run the maze. The consecutive subject reached the starting point about the same time the preceding subject left the area. The subjects thus rotated until each had completed four trials.

The Maze

The total linear distance of the maze was seventy yards. It consisted of right angled turns, acute angled turns, circles and straight lines. Gates were placed at predetermined spots to keep the subject on the path. To successfully complete a trial run the subject was required to run between the gates. The maze is illustrated in Figure 1.

Statistical Procedure

An F-test was used to compare the effectiveness of learning among the three groups. Observations were made
Figure 1
Maze

The numbers adjacent to the segment or circle represent the linear distance of that segment in yards. The x represents the approximate location of each gate.
both between and within groups on all five trial runs. Where significant differences were observed, Tukey's post hoc test was used to determine which groups differed.
CHAPTER IV

RESULTS AND DISCUSSION

The problem under consideration in this study was to determine whether a knowledge of scientific principles would be beneficial in running a maze. Three groups of seventh grade boys enrolled in their respective physical education classes were used as subjects in this investigation. Group I was given a lecture and a demonstration of abstract scientific principles pertinent to the task. Group II was given a lecture and a demonstration of the same scientific principles which were applied specifically to the maze. Group III which functioned as a control group was given an unrelated lecture. All subjects were pretested on a twenty-five yard run and then completed five trial runs of the maze. The purpose of this chapter is to present an analysis of the data relative to the nature of the study.

The data of this study were analyzed to determine: (1) whether the groups were equated equally, and, (2) whether a knowledge of scientific principles did effect
significant changes in running the maze. Included in this chapter will be a discussion of the findings.

**Significance of Difference Between the Groups**

While the three classes were randomly assigned to treatments, the subjects were not randomly assigned to the classes. Due to this it was essential to establish the fact that the groups were representative of the same population before the experiment was begun. An analysis of variance test was used to determine if a significant difference existed between the three groups on the parameter of running times for the twenty-five yard pre-test. The analysis of the mean time score of the pre-test produced an F value which was statistically significant. A summary of this analysis is contained in Table 1. The author thus concluded that at least two of the three means are different and that the sample differences are not due to chance at the .03 level of confidence.

Since the group means were different, a transformation of the data was conducted. This transformation consisted of subtracting the time of the twenty-five yard pre-test from each trial run of the maze. The purpose of this transformation was to factor out the variable of
Table 1

25-yard Pre-test

<table>
<thead>
<tr>
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<th>Mean Square</th>
<th>Degrees of Freedom</th>
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<tr>
<td>Total</td>
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<td></td>
<td>4.77</td>
<td>4.69</td>
<td>4.60</td>
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</table>

straight running speed from the other variables which may be critical to successful completion of the task. Table 2 depicts the mean group scores decreased by the pre-test scores for each of the trial runs.

Table 2

Mean Score of Each Maze Trial*

<table>
<thead>
<tr>
<th>Trial</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>14.67</td>
<td>13.98</td>
<td>13.91</td>
<td>13.76</td>
<td>13.56</td>
</tr>
<tr>
<td>Group II</td>
<td>13.75</td>
<td>14.10</td>
<td>13.84</td>
<td>13.81</td>
<td>13.74</td>
</tr>
<tr>
<td>Group III</td>
<td>14.49</td>
<td>14.31</td>
<td>14.24</td>
<td>14.08</td>
<td>14.01</td>
</tr>
</tbody>
</table>

* Scores represent time in seconds for the maze decreased by the time in seconds for the 25-yard dash.
Figure 2 is a graphic illustration of each Group mean of the transformed data for each time trial.

The analysis of differences illustrated in Table 3 shows a significant difference within the Groups over all trials with an F-ratio of 8.66. This was significant at better than the .01 level of significance. Also, Table 3 shows a significant difference within Groups by trials. The F-ratio of 19.20 was significant at better than the .01 level of confidence.

Table 3

Analysis Within Groups by Trials
and
Within Trial Differences

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean Square</th>
<th>Degrees of Freedom</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Trials</td>
<td>4.40</td>
<td>4</td>
<td>19.20</td>
<td>.01</td>
</tr>
<tr>
<td>Within Groups by Trials</td>
<td>1.99</td>
<td>8</td>
<td>8.66</td>
<td>.01</td>
</tr>
<tr>
<td>Within Trial Error</td>
<td>.23</td>
<td>448</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>.30</td>
<td>460</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The F test indicated that there was a significant difference between the groups on the maze trials. Since
Figure 2

Comparison of Means of the Groups by Trial

Time in Seconds

Trials

**Significant at the .01 level

Group I

---Group II

....Group III
it does not indicate which groups differed or which trials differed, a simple effects test was used to determine where these differences occurred. Table 4 illustrates the results of Tukey's test (3:89).

Table 4
Group Difference at Trial 1

<table>
<thead>
<tr>
<th>Group</th>
<th>II</th>
<th>III</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>13.75</td>
<td>.74**</td>
<td>.92**</td>
</tr>
<tr>
<td>III</td>
<td>14.49</td>
<td></td>
<td>.17</td>
</tr>
<tr>
<td>I</td>
<td>14.67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Significant at the .01 level

The results of Table 4 indicate that the performance of Group II at Trial 1 was better than that of either Group I or Group III. This was significant at the .01 level of confidence. Further, on all other trials tests, no significant differences were found.

Discussion of the Findings

Significant differences were found only between Group II and Groups I and III on the first time trial. It is apparent from the data that the subjects learned to
run the maze. This is illustrated in Figure 2 by the slope of the lines and the significant F across the trials.

Figure 2 also illustrates the fact that the learning curves for each of the Groups was different throughout the trials. It would seem that the subjects of Groups I and III acquired their knowledge and skill in running the maze after completing the initial trial. The lectures did not seem to assist them on Trial 1. These two groups did not significantly improve their scores after the second trial.

The learning curve of Group I regressed at Trial 2 and improved with each trial thereafter. This superior score on Trial 1 may be attributed to the demonstration-lecture they received. From the lecture and demonstration of the scientific principles applied directly to the maze, the subjects of Group I learned the principles and effectively applied them to running the maze at Trial 1. However, trials two through five were run on subsequent days. It is possible that the subjects began to think about and experiment with their own ideas of how to run the maze. A result of this thinking permitted the effects of trial and error to take precedence over the use of known principles in running the maze. Some of the applications
of the scientific principles may have been forgotten by the subjects.

The improvement of the Group II subjects from trials three to five could possibly be attributed to rediscovering the principles as a result of running the maze. This experience permitted recollection of the principles and their applications such that the mean score of the fifth trial approximately equaled the mean score of Trial 1.

Summary

This chapter has summarized the results of the analysis of the data. The only significant differences found were between the mean scores of Group II and Groups I and III on Trial 1 of running the maze. Upon completion of the fifth trial all groups had significantly improved their performance but the differences among the groups were not significant.
CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the effectiveness of a knowledge of scientific principles on running a maze.

One hundred fifteen students in three seventh grade classes at Millikan Junior High School served as subjects for this study. The groups were randomly assigned to three treatments: Group I received a lecture on abstract scientific principles; Group II received the scientific principles with application specifically to the maze; and, Group III received an unrelated lecture and served as the control group. The study lasted three days with a twenty-five yard dash as a pre-test.

On the first day the lectures and demonstrations were given to the respective groups. After hearing the lecture, they received a brief explanation of the task and then ran Trial 1. Because of the size of each group and because of the time required to complete one trial run,
each group was halved. The first half ran four additional trials the second day and the second half of each group ran four additional trials the third day. Each group was given a brief review of their respective lectures prior to the running of the last four trials.

An analysis of variance test was used to determine the significance of between-group differences. Tukey's test of simple effects was used to determine which groups differed from each other and on which trials they differed.

Conclusions

Within the limitations outlined in chapter one, the following conclusions seem justified:

(1) Group II demonstrated significantly greater skill for running the maze on Trial 1 only.

(2) The hypothesis proposed in this study:—Knowledge of scientific principles of motion would not affect the learning process in the gross motor skill of running a maze - was rejected for Trial 1, but was accepted for trials two through five.

(3) Apparently the discussion of principles in their abstract form is not sufficient to result in improved performance in junior high school subjects. However, the
discussion of these principles and then application to a specific task may result in improved initial performance but not subsequent performance.

Some possible reasons for accepting the hypothesis are:

(1) Group II may have been affected by the ceiling effect. That is, on the first trial, their performance was so good that they had already reached their peak. This is borne out by the fact that the score for Group II on Trial 1 is as good or better than any of the groups in Trial 5. Consequently Group II could not improve on their initial effort and random changes in performance were necessarily directed toward an increase in time.

(2) The task may have been too simple. After one trial run of the maze, it is possible that each subject gained sufficient insight for the task to overshadow the purported beneficial effects of the prior knowledge of the principles involved.

**Recommendations for Future Study**

Due to the limitations of this study, the following recommendations are made for future study:

(1) Future studies of this type might investigate a
situation in which the subject would complete the entire set of trials on the same day. This study suggested that alternate days may facilitate significant changes in factors of motivation, retention and forgetting.

(2) This same study may be repeated at different grade levels for the purpose of ascertaining whether there is a maturational level at which knowledge of principles may be most effective.

(3) Attitudinal surveys of the student may be undertaken to study differences in classes that utilize scientific principles as compared to traditional classes.
# BIBLIOGRAPHY

## Books


## Periodicals


15. Gustafson, William F. "A mechanical analysis of selected gymnastics on the horizontal bar, the parallel bar, the side horse, the still rings, and the swinging rings." Unpublished Doctoral Dissertation, University of Iowa, 1955.


APPENDICES
APPENDIX A

Lecture

Principles Only
Today, a part of your physical education class is to watch the following demonstrations about scientific principles of balance and motion. Think about what you see and how you might apply the principles to physical education.

**Inertia:** (Say) A body at rest or in motion tends to remain at rest or in motion until acted upon by some other force.

**Direction:** Show a ball rolling down a plastic runway with a gradual, flat, L-shaped turn.

(Say) The ball continued in the direction of its original movement. The flat curve had little or no effect on the direction the ball rolled.

Show the ball rolling down a plastic runway with a gradual, curved, L-shaped turn.

(Say) The lean or bank of the curve was sufficient to change the direction of the ball.

**Speed:** Repeat the above demonstration. Raise the height of the runway to illustrate the effect of increased speed on the curved turn.

(Say) The lean or bank of the curve did have an effect on changing the direction of the ball. The ball tended to travel in its original direction.
Lower the height of the runway and repeat the same demonstration.

(Say) With a slower speed the lean or bank of the curve easily changed the direction of the ball.

Center of Gravity: (Say) Objects of different sizes and shapes have different centers of gravity.

Ball: (Say) The center of gravity of the ball is located directly in the center of the ball.

Dowel: (Say) The center of gravity of the dowel is in the middle and in the center of the dowel.

Wood: (Say) The center of gravity is in the center of this block of wood.

Base of Support: Using the dowel and the block of wood to demonstrate the aid of a wide base of support in directional changes.

Dowel: (Say) It is not too difficult to tip the dowel over.

Dowel in wider base: (Say) If the dowel has a wider base of support, it is a little more difficult to tip it over.

Block of wood: Change the block of wood to its different bases. (Say) Although the center of gravity does not change as one switches the block of wood to its
different bases, when it is on the widest base of support, it is the most difficult to tip over.

**Height of Center of Gravity:** Use two dowels with different heights but the same base. (Say) The centers of gravity of the two dowels differ only in their height. The dowel with the highest center of gravity tips over much more easily than the dowel with the lower center of gravity.

Block of wood: Switch the block of wood to its different bases. (Say) Although the center of gravity of the block of wood did not change, its height did. It is much easier to tip over if the center of gravity was at its highest point.

**Appendages:** Use a 'frictionless' twister board to demonstrate the use of the appendages as aids to changing direction.

Arms next to the body: (Say) The arm and legs in this position do not help much in making me turn.

Arms out, knees bent: (Say) Watch the effect on turning when I move and twist my body.

**Summary:** (Say) Remember, for an object to turn effectively while it is moving it should: (1) Lean into the turn, (2) Slow down, (3) Lower its center of gravity, (4) Widen its base of support, and (5) Use levers for balance.
Instructions to Run the Maze

You are about to run a maze. The maze consists of lines, circles and angles formed by masking tape on an asphalt surface. Think about what I have said and how you might apply this to run the maze. You will be timed for each trial. Do not say anything that might help anyone else as your times are to be compared. Come to the starting line when it is your turn. The starter will say 'Ready - Go'. Run as fast as you can through the end of the maze. Follow the line as closely as you can. You must pass through the line side of each gate or you will be disqualified. Good luck.
APPENDIX B

Lecture

Principles Applied to the Maze
Today, as a part of your physical education class, you will be asked to run a maze. The maze is made up of curved lines, straight lines, sharp turns and corners. To follow these lines it will be necessary for you to change directions. As an aid to running the maze, I will demonstrate some scientific principles of motion and balance. Think about what you will be seeing and try to apply these principles to running the maze.

Inertia: (Say) A body at rest or in motion tends to remain at rest or in motion until acted upon by some other force.

Direction: Show a ball rolling down a plastic runway with a gradual, flat, L-shaped turn.

(Say) The ball continued in the direction of its original movement. The flat curve had little or no effect on the direction of the ball.

Show a ball rolling down a plastic runway with a gradual, curved, L-shaped turn.

(Say) The lean or bank of the curve was sufficient to change the direction of the ball. As you run the maze and come to a turn, lean in the direction of the turn.
**Speed:** Repeat the above demonstrations. Raise the height of the runway to illustrate the effect of increased speed on the curved turn.

(Say) The lean or bank of the curve did have an effect on changing the direction of the ball. However, the ball tended to travel in its original direction. When you run the maze and as you come to a turn, you should slow down a little and lean in the direction of the turn.

**Center of Gravity:** (Say) Objects of different sizes and shapes have different centers of gravity.

Ball: (Say) The center of gravity of the ball is located directly in the center of the ball.

Dowel: (Say) The center of gravity of the dowel is in the middle and the center of the dowel.

Wood: (Say) The center of gravity is in the center of this block of wood. As you run the maze, twisting and turning, your center of gravity will change.

**Base of Support:** Use the dowel and block of wood to demonstrate the aid of a wide base of support in directional changes.

Dowel: (Say) It is not too difficult to tip the dowel over.

Dowel in a wider base: (Say) If the dowel has
a wider base of support, it is a little more difficult to tip over.

Wood: Change the block of wood to its different bases. (Say) Although the center of gravity does not change as one switches the block of wood to its different bases, when it is on the widest base of support, it is the most difficult to tip over. When you are going to turn a corner as you run the maze, widen your steps in the direction of the lean as you slow down to make the turns and to keep your balance.

**Height of Center of Gravity:** Use two dowels with different heights but the same size base. (Say) The centers of gravity of the two dowels differ only in their height. The dowel with the highest center of gravity tips over more easily than the dowel with a lower center of gravity.

Wood: Switch the block of wood to its different bases. (Say) Although the center of gravity did not change within the block of wood, its height did. It is much easier to tip over if the center of gravity was at its highest point. As you run the maze and come to a turn, lower your center of gravity.

**Appendages:** Use a 'frictionless' twister board to demonstrate the use of the appendages as aids in changing direction.
Arms next to the body: (Say) The arms and legs in this position do not help much in making me turn.

Arms out, knees bent: (Say) Watch the effect on turning when I move and swing my arms around. As you run the maze and come to a turn, use your arms for balance and power. Bend your knees as you plant your feet while making your turn and push off hard with your feet.

Summary: Remember when you run the maze to: (1) lean into the turn, (2) slow down a little, (3) widen your steps, (4) lower your center of gravity by bending your knees slightly, and, (5) use your arms.

Instructions to Run the Maze

You are about to run a maze. The maze consists of lines, circles and angles formed by masking tape on an asphalt surface. Think about what I have said and how you might apply this to run the maze. You will be timed for each trial. Do not say anything that might help anyone else as your times are to be compared. Come to the starting line when it is your turn. The starter will say, 'Ready - Go'. Run as fast as you can through the end of the maze. Follow the line as closely as you can. You must pass the line side of each gate or you will be disqualified. Good luck.
APPENDIX C

Unrelated Lecture
I would like to thank the Physical Education Department of Millikan Junior High School for allowing me to work with you this period. It is no doubt that some of you have seen me in the department visiting with your teachers. Some of you have commented to me whether I am going to be a part of the physical education department. Whatever the intentions, we have something exciting that is going to happen so listen carefully. There are some instructions that you must not miss. I will say them only once. Before I give you these instructions, I must comment on some items.

First, as you know the rumors about peace have been indicated by the news media. The Viet Nam situation has never been a pleasant one. I really must say I am very excited about the peace rumors as well as most people are. Wars of any type are not the most pleasant thing to talk about. Young men lose their lives. Some are maimed for life. However, there is a national feeling of expression of principles. Are we to let Communism or a Democracy of our own type to prevail? This question can only be answered by each of you. Isn't it great that in America we can have the right to voice our opinion.

Secondly, we are deep into the political scene of
McGovern and Nixon running for President. Each man has decided how they are going to express their opinions for political gain. It is necessary for each of us to spend some time considering what the issues really are. When the election time comes, each of us should be able to make a reasonable assessment of the personal stances of each of these men and then go to the polls to express our feeling.

I think I saw on TV one of the most unusual touchdowns in football. Did any of you see it? It was a pass play. Two defenders of the Kansas City Chiefs went up in the air to defend against a forward pass. One of them tipped the ball in such a way that it hit the back of the second defender's leg. The ball bounced high enough and sideways so that a second offensive player caught it in full stride and ran about sixty yards for a touchdown.

Talk about the luck of the Irish.

You have been very attentive. Now listen carefully to the following instructions:

Instructions to Run the Maze

You are about to run a maze. The maze consists of lines, circles and angles formed by masking tape on an asphalt surface. Think about what I have said and how you
might apply this to run the maze. You will be timed for each trial. Do not say anything that might help anyone else as your times are to be compared. Come to the starting line when it is your turn. The starter will say 'Ready - Go'. Run as fast as you can through the end of the maze. Follow the line as closely as you can. You must pass the line side of each gate or you will be dis-qualified. Good luck.