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The purpose of this study was to investigate the difference in the improvement level of students in learning specific tumbling stunts under two differing methods of instruction. The study was conducted to determine whether a traditional teaching approach consisting of demonstration, explanation, and teacher directed practice, as contrasted to a traditional teaching approach with the addition of an understanding of the mechanical principles governing the stunts differed with regard to learning.

Subjects included thirty-nine college freshman and sophomore women enrolled in two beginning gymnastic classes. The study was conducted over a four week period. Ratings for each subject on each of the twelve beginning tumbling stunts were determined by three raters both at the beginning and end of the study. In addition three new tumbling stunts were tested at the time of the re-test.

Data was treated statistically to determine any differences in tumbling ability between the experimental and control groups at the beginning of the study, to determine any differences between the two groups in general motor ability, to determine if improvement in tumbling skill occurred within each group from the beginning to the end of the study, to determine if there was a difference in the improvement level of tumbling

skill between the two groups from the beginning to the end of the study, to determine if there was a difference in the tumbling skill between the two groups at the end of the study, and to determine if there was a difference in the skill level between the groups on the performance of three additional stunts.

Conclusions were drawn that both the traditional approach and the traditional approach with an emphasis on mechanical principles resulted in improvement in skill for all subjects in each of the twelve stunts taught. Neither teaching approach proved more effective in the improvement of tumbling skill from the beginning to the end of the study, and neither teaching approach proved more effective in the final tumbling skill of all subjects although the experimental approach to teaching was more effective than the traditional approach in the improvement of two stunts--the forward roll and round-off. Neither group was able to learn three new stunts that had not been practiced or explained more effectively than the other group.

A STUDY OF THE EFFECT OF TWO DIFFERENT METHODS OF TEACHING ON GYMNASTICS

by

Judith Ann Fath

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Thesis Adviser

APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

Thesis Adviser: Celeste Ulrich

Oral Examination Committee Members:

Rosemary McGee

Paul E. Lepley

Marjorie Leonard

June 17, 1968

Date of Examination

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TABLE OF CONTENTS

CHAPTER PAGE

CHAPTER PAGE

LIST OF TABLES

CHAPTER I

INTRODUCTION

Methods of teaching physical education have changed gradually during the last one hundred years. The evolution of the science of movement has been responsible for some of these changes. Other influences have been brought about by alteration in educational theory, innovations in methodology and the integral part psychology, ethics, and sociology have played in the teaching of physical education.

Aristotle, in 300 B. C., described the actions of rotary and translatory motion in walking and began to describe the role of the center of gravity, the laws of motion, and of leverage.

For the next one thousand years the study of human muscular movement was in a relatively static phase. In the fifteenth century Leonardo da Vinci, a great artist and scientist, described the mechanics of body movement. He wrote

> Mechanical science is the noblest and above all others the most useful, seeing that by means of it all animated bodies which have movement perform all their actions. (45:iii)

Da Vinci studied the anatomy of the human body and performed many dissections for both his scientific curiosity and to make his art more realistic.

Isaac Newton, in the eighteenth century, described the relationship between forces and their effects. He described the laws of rest and movement and described the parallelogram of forces applicable to a study of the angle at which muscles pull on the bones of the body.

Scientists were able to proceed, utilizing such insights to analyze movements and body actions. The recent uses of the electromyographic equipment and cinematography have aided researchers in their quest for meaning in movement.

Physical educators have been able to apply these all important principles of movement to physical education; however, the literature does not suggest that such application has been made on a large scale. Application and use of the mechanics of movement would appear to be a sound basis upon which to structure teaching of activities. If the principles related to force, motion, equilibrium, and projectiles are followed, teachers and students should be able to learn not only the most efficient movement, but also the intellectual premises behind such movement. With such an understanding, hopefully they could apply knowledges from one skill to another. Souder and Hill have stated that,

> . . . the ability to move well is largely dependent upon a knowledge and understanding of the human body and that this knowledge not only reveals the great possibilities of human movement, but also discloses the reasons for the laws which govern movement. (39:3)

An approach to teaching which utilizes knowledge of movement principles gives a sound basis for teaching all sports. Unfortunately there is a paucity of research in the area of the principles of mechanics and their application in learning situations involving gross muscle groups. Bunn has stated that,

> . . . only a few educators have explored the science of mechanics and physics and have examined the application of the principles involved therein to the motor movements of human beings. (11:viii)

Some twentieth century physical educators that have incorporated the work of anatomists, physiologists, and physicists and have applied it to the science of movement have been: A. V. Hill, C. H. McCloy, T. Cureton, and G. Scott. It can be noted by the limited evidence in this field that more physical educators must revive, revise, and develop the work begun by scientists so many centuries ago.

Gymnastic teaching has progressed from the formal command method, to the teacher-directed approach involving the traditional method of presentation, to the present day experimentation in problem solving. The traditional method of demonstration, explanation, and teacher-directed practice is probably most prevalent today. During the demonstration and explanation students are told to place the hands, head, torso, legs, and feet, in particular positions, when to initiate a push, how hard to snap and how far to lean. In most situations each stunt is taught by itself and an explanation similar to the above one is given by the instructor for each of the stunts taught. All gymnastic stunts are based on sound principles of equilibrium, force, and motion. It was the writer's belief that if students understood the basic principles of movement they would be able to apply these from one stunt to another and see relationships necessary for successful execution of stunts.

This study was undertaken to see if a knowledge of the principles of mechanics and their application in tumbling skills improves the performance of pupils in a physical education class.

CHAPTER II

STATEMENT OF THE PROBLEM

It was the purpose of this study to investigate the difference in the improvement of students in learning specific beginning tumbling stunts over a period of four weeks under two differing methods of instruction. The study was conducted to determine whether a traditional teaching approach with regard to teaching methodology as contrasted to a traditional teaching approach with the addition of one variable--an understanding of the mechanical principles governing the stunts--differed with regard to learning.

CHAPTER III

REVIEW OF LITERATURE

Value of Mechanical Understanding

Physical educators need a working knowledge of the mechanical principles related to movement if they are to teach in an efficient manner. An understanding of the mechanics of movement may facilitate learning by helping the student recognize and correct errors in his movement techniques. These mechanics of movement are based on the laws of physics as applied to human motion. The student who is taught mechanical principles should be able to apply these concepts; and such knowledge should enable him to learn skills on his own, with only minimal assistance.

If mechanical understanding is mastered, the student should be able to ascertain relations between the laws governing human movement and the skill to be learned, thus facilitating the learning and making it more meaningful. Such understanding could reduce the learning time by eliminating unnecessary responses, and permitting the student to visualize the stunt correctly. (54:67) McCloy has stated, "The teaching of all sport skills should be according to mechanically correct principles." (30:54) This teaching should be at a level of understanding suitable for the particular group to be taught.

Broer stated,

> If the physical education teacher understands the basic mechanical principles related to human motion he can teach knowledges important to all skills through any specific activity. (5:328)

Thus, principles should be related from one activity to another. In this way students could apply their knowledges and would not have to relearn specific parts of every skill. Although students perform in varying manners, the mechanical principles pertaining to the skill techniques are the same for all.

A major function of the physical education teacher is to help each student learn how to perform in a skilled way. When a move is executed poorly it is the teacher's job to correct the error so that a successful maneuver may be executed. A correct analysis of the skill through the use of mechanically correct principles helps make this possible. The teacher should be able to tell the student why he has been unable to accomplish his purpose. (47:68) Alley (47) pointed out that many teachers teach skills incorrectly because they neglect mechanically sound principles in their teaching. They teach the way they themselves learned, giving no thought to the correctness of the execution of the technique; or they imitate champions, not taking into consideration that if the champion changed his technique he might be even more successful. It should also be acknowledged that the champion may have anomolies which insist upon specific skill patterns. The teacher of physical education should be able to analyze skills so that he may then evaluate new techniques and either accept or reject these on this basis of knowledge.

In summing up the value of a mechanical understanding, McCloy stated,

> . . . wider application of the mechanical analysis of all skills pertinent to physical education will lead to better teaching of these skills and to about twice as rapid learning upon the part of the learners. (30:63)

Use of Mechanical Principles in Research

Within the framework of various teaching methodologies many studies have been undertaken showing how knowledges of basic principles affect learning. Once a principle is understood it can be related, through the guidance of a teacher, to similar activities whether they be in the use of related gross muscle groups or involving isolated muscle groups.

Ruger (77) found that subjects who had an understanding in the principles related to solving mechanical puzzles had greater success in solving specific movement puzzles than students who did not seek these principles.

In one of the earlier studies utilizing the effect of principles, Judd (67) taught one group of fifth and sixth graders the principles of refraction and used a second group as the control group. Both groups threw darts at a target placed twelve inches under water. He then moved the target four inches under water and found that the group taught the principles was able to apply these principles and had greater success in performance than the group taught without learning the principles of refraction.

Hildreth (65) concluded that students who had an understanding of mechanics were able to construct jigsaw puzzles faster than students who proceeded uninstructed using the trial and error method.

Daughtery (59) concluded that junior high school boys taught to apply mechanical principles in selected skills demonstrated greater accuracy and force than students performing without knowledge of these principles.

Barrett (86) taught two groups of students four swimming strokes which included the front crawl, back crawl, elementary back stroke, and breast stroke. One group was taught in the traditional method by use of demonstration, and explanation; and the second group was taught to understand the mechanical principles governing their movement. Barrett found that an understanding of mechanical principles governing the four selected swimming strokes facilitated learning.

Zuber (93) hypothesized that students taught the basic laws governing particular gymnastic stunts would learn faster than students who did not understand these principles. The eight stunts tested were selected because their successful execution was not dependent upon strength. Zuber concluded that there was no difference in the rate of learning of these selected stunts. He also concluded that the learning rate appeared to increase as the student gained more background in the mechanical laws which govern success or failure of a gymnastic stunt.

Mikesell (90) taught one group badminton using the traditional method and a second group by placing emphasis on an understanding of the mechanical principles applied to badminton skills. After ten weeks of instruction no differences were found between the two groups, but between the sixth and tenth weeks the group taught to understand the principles governing the skills showed significant improvement on the wall volley test. Mikesell concluded that facilitation of learning appeared to increase with an understanding of the application of the mechanical principles.

Colville (88) taught one group of subjects three mechanical principles related to three motor skills and a second group the same motor skills without reference to the mechanical principles. She found that instruction in the mechanical principles did not facilitate initial learning of the selected skill, but did facilitate learning of a similar, more complicated skill.

> A pupil who understands principles related to one skill may master a related skill more rapidly than the pupil whose experience has been restricted to specific instruction in techniques without explanation of pertinent facts. (88:1)

Cobane (87) found that groups taught tennis with an emphasis on mechanical principles did not differ significantly from groups taught by the traditional method. The group taught with reference to the mechanical principles was equally effective in learning these skills despite the loss of practice time, and also proved to have a better knowledge and understanding as shown by a written test.

These research findings indicate that the use of mechanical principles in instruction is dependent on the task to be taught and the age at which the students are tested. Although the research does not show that students learning mechanical principles are superior to students taught without reference to these principles, it does indicate that this method of teaching is as effective.

Nature of Learning

"The relatively permanent change in behavior due to experience or training, . . ." is termed learning. (71:68) One type of learning known as motor learning ". . . is the rather permanent change in motor performance brought about through practice and excludes a change from maturation, drugs, and the like." (15:23)

Man is constantly learning, whether in the informal atmosphere of his home or in the more formal setting of the school. The child learns that certain responses bring him satisfaction while others thwart his desires. He learns if one response is unsatisfactory to try others. Learning occurs as the child grows.

Children may learn in various ways. These processes include rote learning, conditioning, trial and error, goal seeking, insightful learning, meaningful activity, and problem solving. Of these processes it has been found that the last three are the most effective in facilitating retention and rate of learning. Understanding of principles rather than memorization of isolated facts can aid in retention. (1:28)

Students must be guided by the teacher in the amount, kind, and distribution of practice. Thus the job of the teacher is to help the student understand. The child cannot be expected to assimilate knowledge without understanding.

The most recent and important developments in learning have been in the field of cognition. Once students were expected to learn through constant drill and practice, reacting blindly to the demands of the teacher. Educators and psychologists are now beginning to see the need for exploration, experimentation, discovery, and understanding, leading to the formulation of workable concepts. (1:3)

Learning Theories

Over the years various theories have been developed, used, and altered to help educators understand the best situations to induce learning.

A theory derived by Thorndike has been called the S-R Theory. The stimulus causes a specific response similar to the way a mechanism would respond to the press of a button. This theory advocates the use of drill in learning and the teaching of facts to strengthen the neural bond between the stimulus and response. The S-R Theory tends to make learning mechanical. The law of exercise states that practice helps the individual gain satisfactory results which strengthen the neural bonds, but that this repetition in itself is not enough to insure that learning will take place. In the law of effect Thorndike contended that satisfying results and experiences that are rewarded will strengthen the bonds and the individual will be more inclined to continue the said activity. The individual learns more rapidly and more effectively when he is ready and interested in his work. This is known as the law of readiness. (42:56, 8, 28, 1) Thorndike's theory contended that the learner must be ready to learn, that he must have satisfactory experiences, and that he practice the subject matter in order for the best conditions of learning to take place.

In physical education Thorndike's theory of the conditioned response was probably utilized in the more formal teaching seen in the early 1900's. It would suggest teaching by command, expecting the individual to react quickly and with minimal reasoning, offering each class the activity it is prepared to learn, and trying to make experiences satisfactory for the learner.

A second theory of learning called the field theory states that the individual learns matter as a whole and then may analyze from this complex whole to the simple parts. It stresses that subject matter must be adapted to the individual who should be thought of as a person rather than a fixture. The advocates of this theory hold learning to be a matter of insight and purpose. This is part of the Gestalt organization which is based on the fact that a trace exists in the brain and makes a carry-over from one experience to another. Certain laws operate in connection with this trace theory. The first is the law of similarity which says that individuals tend to group together objects similar in form, color, and shape. In the law of proximity it is assumed that objects which are close together are more rapidly remembered than those separated by greater distances. The law of closure states that closed areas are more stable than open ones and therefore the individual is more inclined toward completion of nonsymmetrical forms. Perception tends to organize figures according to their symmetrical shapes. Thus a circle continues as a circle and a rectangle as a rectangle. This is known as the law of continuation. (15, 18, 42:212-216)

Field theorists would teach physical skills as a whole rather than breaking down the total skill pattern into simple small parts. For example, a lay-up shot in basketball would be taught in one unit rather than teaching a dribble, a shot, and then putting the two parts together. A golf swing would not be analyzed in parts, but the entire swing from start to follow-through would be learned at the same time. Thus, field theorists would carry this holistic concept into all activities utilizing the various aspects of the trace theory.

The functional theorists contend that learning takes place when a problem is presented to the student in a realistic situation. They would emphasize an activity rather than the content. The concept around which functionalism revolves is adaptation. Man learns in order to survive in his environment. In order to adjust to this environment he uses his intellectual processes as well as his physical abilities. He learns by acting and reacts according to his physiological needs. (42:355, 15)

Physical educators would teach skills as part of a game situation rather than isolating them. Thus, students would spend less time in drill and more time in a game situation experiencing the problems necessary for the application of the skill. Practice of these skills would be incorporated into lead-up games as well, rather than set aside as separate entities.

The three above-mentioned theories have both similarities and differences. Because educational processes differ, the best methods of learning in one situation may not be the same in a different situation. Thus, educators probably should meet the demands of learning through a synthesis of all these learning theories. Thorpe and Schmuller said that,

> . . . with respect for education learning should be considered from an eclectic point of view, not in the sense of working out convenient principles designed to fit passing fads or methods, but a patterned eclecticism, which endeavors to construct an orderly framework which is both strong in itself and sufficiently flexible to meet the demands put upon it by vital and growing learners. (42:437)

Factors and Research Related to Retention

Certain factors promote the retention of learned material and the rate at which the student learns. Curves of learning studied by Ragsdale (34), Hartman (21) and Sharman (37) have shown as a person begins learning there is an initial spurt where progress proceeds rapidly. Then as learning proceeds, plateaus are reached in which there is little or no progress. These plateaus may be followed by either slight or marked acceleration followed by other plateaus. Learning curves differ. In some instances the learner may start off making no progress and then accelerate markedly. If practice continues once the goal is achieved the level of learning will remain steady, but if practice is discontinued the level will drop. These plateaus in the learning curve may be due to lack of motivation, physiological limits, fatigue, lack of understanding in the attainment of the goal, or a change in the working conditions.

The retention of learned material depends on how well the material was initially learned, how meaningful the material was to the learner, how well it was liked, and how well the skill related to other skills. (34, 15, 71)

Motor skills seem to be retained over a long period of time. Cronback (16) stated this longer retention period may be due to the overlearning factor. In overlearning the student learns a material or skill so thoroughly that it is highly resistant to extinction. (16:393) Thus, the initial learning, along with the practice of a skill, aids in retention.

Bell (50) found after testing subjects on a pursuit motor task that after one year without practice scores decreased only 29 percent, but were completely recovered after eight trials. He concluded that retention existed up to one year after initial learning, and relearning was more rapid than the original learning, probably due to overlearning of the motor task.

Braden (51) conducted a ball tossing experiment in which subjects tossed 200 balls into a box twelve feet away each day for eighteen days. Two retrials were given, after twenty-two months and twenty-eight months. These retests showed marked improvement in the balls accurately thrown in the retrials. Using the first ten practices as a criterion in the first experiment, 490 balls were accurately thrown in the box, in the first retrial 694 balls, and in the second retrial 813 balls were accurately thrown. Thus, Braden suggested that retention did exist and relearning of ball tossing was rapid.

Hill (66) tested himself after twenty-five year intervals on retention of typing skills. He found a 50 percent retention after twenty-five years and a 25 percent retention after fifty years.

Purdy and Lockhart (75) tested college women on five novel motor skills which included a nickel toss, ball toss, foot volley, lacrosse throw and catch, and ability on a bongo board. After one year the same subjects were retested and it was concluded that motor skills are not rapidly forgotten and that rapid learning takes place after an interval of one year without practice.

Ragsdale categorized the factors which aid retention as follows: learning meaningful skills, overlearning, learning with the intent to retain over a period of time, and learning activities which are liked. (34:81)

Factors and Research Related to Rate of Learning

Factors affecting rate of learning are motivation, readiness, length of practice period, a knowledge of the results, learning meaningful material, and the whole method of learning.

The amount and rate of learning is highly dependent on the individual's desire and motivation to learn. If the student is eager to learn he will progress rapidly toward the desired goal. (1, 64, 18)

The length of the practice period is of prime concern to educators. Evidence seems to indicate that distributed practice periods are better than massed practice periods, or that short, frequent practices are preferable to long, infrequent ones in facilitating learning. (34:84) Knapp and Dixon (69) in a study in juggling found that a five minute daily practice facilitated more rapid learning than a fifteen minute practice every other day. Young (83), in a study of two types of distributive practices, found that the rate of learning badminton was more rapid when classes met two days a week as compared with four days a week; but the rate of learning in archery was more rapid in the four-day-a-week practice period. The length of the practice periods is dependent on the skill level of the performer, his motivation, and the complexity of the skill to be learned. (71:72) Ragsdale explained this phenomenon of shorter practice periods in terms of favoring higher motivation, better physiological conditions, more concentrated effort and favorable reminiscence. (34:84)

Studies in learning of motor skills have shown the whole method of learning to produce a faster rate of learning as compared to the part method, as long as the skill is not highly complex. Wickstrom (82) in a study of basic tumbling and gymnastics found the whole method significantly more effective in teaching the kip. Shay (80) also found the whole learning method superior to the part method in learning a kip on the horizontal bars. Both of the above studies were performed using male college students as subjects. The criterion for learning was three consecutive successful trials of the stunt. Niemeyer (32) concluded that swimmers utilizing the whole method learned to swim sooner, farther, and faster, than swimmers taught by the part method. Cross (56) compared the whole and part methods of teaching basketball to ninth grade students. He concluded that the whole method was more successful in teaching moves such as passing and catching, but the progressive part method proved better when more complex moves were taught. This conclusion is in agreement with Ragsdale, who stated that ". . . the method used should depend on the complexity of the activity. . . ." (34:85), and Cratty, who stated that ". . . the whole method usually results in more rapid learning to a given criterion. . . . If the skill is complex then the part method is probably more effective." (15:241)

Saltzman (78) and Greenspoon and Foreman (62) concluded in separate studies that a knowledge of the results of performance aids in the rate at which a subject learns. Utilizing a verbal maze consisting of six pairs of four place numbers Saltzman concluded that when knowledge of results is delayed learning will be slower than in instances where reward is immediate. In the study by Greenspoon and Foreman subjects were asked to draw fifty three-inch straight lines while blindfolded. Four groups of subjects were tested with a ten-second increase in delay of knowledge of the results for each group. It was found that as the length of delay in the results was increased, the rate of learning decreased.

Meaningful material is learned more rapidly than less meaningful material. (34:81) In a study by Barton (49) it was found that beginning typists, working from material similar to that which they would be using on the job, learned more efficiently than those subjects working with isolated symbols.

This evidence seems to indicate that short, frequent practices are better than long, infrequent ones, that the whole method of learning is more effective than the whole part method, and that a knowledge of the results of the performance aid the rate of learning.

History and Value of Gymnastics and Tumbling

Tumbling is a natural activity engaged in by children all over the world. It dates back to the religious ceremonies in Greece and to the use of acrobats by the Roman mimes. Because the Christians frowned on the attitudes concerning the mimes, these people were forced to leave Rome; and they wandered over Europe performing wherever they went. During the periods of the Civil War in the United States, the tumblers joined circuses in America and eventually performed in vaudeville. At the end of the nineteenth century, these performers practiced in the YMCA's and similar clubs while not touring. Thus, amateurs came into contact with expert tumblers enabling the amateurs to learn skills and receive training. At this time gymnasiums were built for the first time at colleges and other institutions. With the interest in physical training growing many people became interested in tumbling and took courses which enabled them to teach physical education. Thus, education began using tumbling as an activity for the development of youngsters. (14:10-31)

Tumbling makes use of the body in performing stunts without the use of apparatus. In contrast to this, gymnastics as we know it today, is a combination of stunts or routines performed with or without apparatus. Gymnastics makes use of the entire body whether the stunts be performed at the beginning or advanced levels.

Gymnastics benefits man's performance potential by helping develop strength, flexibility, endurance, balance, agility, rhythm, and coordination. (14:43) It is a natural activity toward which children are often inclined. A child learns to climb trees, swing on bars and ropes, and tumble on his bed when he is very young. He experiments with his body for the pure fun of seeing just what he can and cannot do.

In physical education class students gain satisfaction in gymnastics by testing themselves for accomplishments. They begin to realize that all individuals are not capable of the same degree of physical accomplishment and thus they begin to respect individual differences. Gymnastics is ultimately striving for beauty in movement by submitting the body to man's will.

The gymnastics programs of today received their start in Germany. Johann Guts Muths, often called the great grandfather of gymnastics, used an outdoor gymnasium equipped with ropes, ladders, vaulting apparatus, and balance beams as early as 1800. The initial aim of gymnastic training in Germany was to develop citizens who possessed strength so they could successfully fight for their country in the time of need. At this same time Frederick Jahn recognized that gymnastics could do more than build up the physical attributes of man. This is evident in his motto, "free in spirit, strong in body, cheerful, intelligent, and dependable." (40:220) Jahn's system of gymnastics was free of strict discipline and because it was a recreational endeavor his pupils helped develop and plan the activities. With his initiative and the help of his pupils they developed an outdoor gymnasium equipped with the apparatus used by Guts Muths and in addition introduced the horizontal bar, side horse, vaulting buck, and parallel bars. The apparatus and gymnasium were open to both the youth and adults in Germany, and Jahn often had as many as five hundred participants at one time. Through his teachings Jahn promoted personal freedom and individualism, both of which were considered dangerous attributes by the leaders of that time. They therefore forbade Jahn to continue his program and eventually arrested him. It wasn't until some years later that the gymnastic exercises were revived and gymnastics became organized for use in the schools.

At the same time Per Henrick Ling of Sweden became interested in gymnastics as a system to develop physical skills helpful in his country's patriotic endeavors. Ling also pioneered the use of physical activity to restore health to weak individuals. Because these exercises were influenced by the military need of the time they were presented in a formal manner similar to military drill and emphasized the development of strength, agility, and bodily control. To meet these goals the stall bars, beams, ladders, climbing poles, and ropes were introduced.

Under the leadership of Franz Nachtegall physical education followed a nationalistic theme in Denmark, similar to those in Germany and Sweden. Nachtegall's program was adapted from the German system. Later, when other educators took over, Denmark adopted Ling's Swedish system of gymnastics, incorporating these with the most valuable Danish exercises.

These three systems of gymnastics had an influence on the development of gymnastics in the United States; but the German Turnverein, a group of German-American youth interested in physical activity, probably had the greatest influence. As the Germans immigrated to the United States, Turner clubs were formed, and from these grew training schools and the incorporation of gymnastics into the American educational system.

After World War I, the emphasis moved to lighter recreational activity and away from gymnastics. Due to the efforts of the Turners, the Swedish gymnastic groups known as the Sokols, and a few colleges and universities, gymnastics managed to survive, but was de-emphasized in favor of recreational activity.

During World War II, military leaders became aware of the decreased strength and fitness of their men and recognized the need for gymnastics. Because of this growing concern many schools incorporated gymnastics into their programs. Also at this time, the development of the trampoline helped gymnastics regain momentum. (25:3-4, 40)

For the past seventeen years the growth of gymnastics has been phenomenal. This may be due to the various national, state, and local clinics held throughout the country involving more and more people each year. Gymnastics magazines, newspaper and television coverage, foreign touring teams, and America's growing interest in the Olympic Games may also be strong influences in the tremendous growth of the sport of gymnastics.

Teaching Methodology

As gymnastics has progressed, the influence of various systems have influenced teaching methods. Various methods in the teaching of gymnastics have volved, been improved upon, and changed, since the first gymnastic class was taught. These methods have been altered depending upon changing educational aims and objectives. Where once individual differences were not considered, the individual is now of prime concern. The methods of teaching have gone through a period of change from the formal command method to the informal problem solving method which is rapidly growing in popularity.

The formal method emphasized drill and command and group performance as precisioned movements. The discipline was teacher-controlled, allowing the students only to react to the command without ever being asked to think. It was military-like in its presentation. Knudsen (27) explained that the command should be given in two parts--the explanatory words and the executive words.

> The explanatory word should contain short and clear explanations as to which exercise should be performed and in what way it should be done. The executive words give the moment at which the exercise is to begin. It must be a short word, preferably of one syllable which can be pronounced distinctly. (27:60)

Bukh also advocated the formal approach using the command method of presentation. He used a set cadence and utilized rhythmical continuity having one exercise lead directly into the next. Bukh was interested not only in the bettering of neuromuscular skill, but in the development of gymnastics as a corrective exercise. (10:7) Skarstrom used signals to "insure unison and uniformity of movement, as well as to train alertness and quickness of response." (38:38)

Ling's formalized system, based on anatomical and physiological concepts, was the basis for Maja Carlquist's rhythmical gymnastics. The natural flowing movements of the body were stressed rather than the rigid unnatural activity of earlier days.

The above methods leaned heavily on the theory of learning derived by Thorndike. The constant drill and repetition seen in the formal teaching method helped reinforce the neural pathway between the stimulus and response.

In the early 1920's a change in the philosophy of teaching was evident. This "new physical education" was still teacher-directed, but more consideration was given to the student as an individual. This "new physical education" had fewer definite requirements, a more elastic program based on sports and recreational activities, and more opportunity for self expression. Wood (46) and Heatherinton (23) were leaders in this new method. They stressed the social and moral values related to physical education as well as the performances and physical aspect. Wood, Heatherington, and other advocates of the "new physical education" stressed self discipline, self control, self direction, and initiative. It was their intent to teach students to think rather than obey. It was at this time that there was a divergence from the formalized systems previously used and an initial move toward the less formal teaching seen today. This "impersonal" method was primarily interested in developing the total individual. It was in agreement with the current learning theory of that day. It follows the field theories of learning which stress that learning takes place as a whole by the total individual.

Gymnastics teaching of today is based mainly on the principles of anatomy, physiology, kinesiology, sociology, and psychology. (2:215-26) The approach used is still teacher-directed, but more freedom is offered the individual to proceed at his own rate. A task is presented the individual to practice on his own with guidance from the teacher and/or students.

Eric Hughs (24) advocated teaching gymnastics as a competitive sport. He theorized that life is competitive and all other sports are competitive; therefore, gymnastics should be taught in a like manner. Hughes pointed out the absence of rules in gymnastics teaching in comparison with other sports. (24:3-4) In competitive gymnastics the four Olympic pieces--the balance beam, uneven parallel bars, horse, and floor exercise--are favored, though tumbling and trampoline may be included. Routines are performed and judged on a ten-point basis according to the rules set up by the Federation of International Gymnastics. Three points are allotted difficulty, two points for the technical value and composition of the routine, and five points for the execution. Deductions are made in accordance with the degree of the faults and the missing parts of a routine. Vaulting is judged in a similar manner, but the pre-assigned difficulty of the vault constitutes the starting point of the deductions. Thus, in a vault worth seven points, the maximum a performer would score is seven. This scoring system is used in all competitive meets, never taking into consideration the skill level of the performers. Thus, beginning gymnasts and Olympic competitors are judged by the same standards. The teaching advocated by Hughes is in opposition to the newer problem-solving approach.

Children learn that there are many ways to answer problems, but certain responses are more efficient than others. As the child grows this self discovery does not cease. To bring this concept into the school, the problem-solving approach is now in evidence. Problem solving is an approach to movement in which the child discovers what his body can do with and without the use of apparatus. It is a framework in which creative thinking takes place. The "best" learning occurs when the student is doing work important to him. The individual who faces a problem and solves this problem by thinking it through, judging various methods, trying these possibilities, and coming up with an answer has learned more effectively than the individual who has the answer formulated for him. (6:111, 28:69)

The teacher's task is to create a suitable atmosphere in which he presents new experiences for the learner. These experiences are given as questions for the child to solve in his own way and at his own rate. The teacher guides the analysis of alternatives with which the students explore. (73) Based on his past experiences the individual produces an idea which is new to him. As his movement vocabulary grows he widens his initial limited choices.

The best learning through the problem-solving method occurs when the teacher accepts individual differences, the individual is accepted for himself, there is a degree of freedom in the working atmosphere, the student does his own thinking with direction or guidance, and a wide range of experiences help the student feel accepted. (6:113)

Teachers must create problems that stimulate students to seek answers. Because a problem may have many answers, students discover various ways in which to react. Though each will solve the problem differently, there are basic processes all will use at arriving at the answer. These processes are: becoming aware of the problem, clarifying the problem, proposing the hypothesis, and finally testing the hypothesis. (41:196)

Through the problem-solving approach the student learns to make judgments and decisions, to have confidence in his own abilities, to seek various methods in answering the problem, therefore creating a self-discipline and understanding. Problem solving allows the student to learn related material easier, to remember the material longer since the solution was his, and fosters an interest in the activity as an end in itself. (50) Briggs (52) suggested that the problem-solving approach sustains interest, emphasizes a high level of thinking, encourages student planning, and fosters self-development.

> A problem-solving approach can provide many opportunities for children to think for themselves and to create. In posing a problem the teacher merely sets the stage, the children play the roles. A creative teacher frees the children and lets them experiment and initiate movements on their own. (74:25)

Problem solving is a method of teaching relatively new to physical education. Within this experience the student seeks to answer a problem through movements he selects or creates. In seeking these answers he must intelligently find methods to use his body in conjunction with his mind through a thinking process. In gymnastics three groups of actions about which this method is concerned are: locomotion, balance, and handling of external objects. The teacher helps the student find what his body can do, such as stretch, curl, twist, turn, circle; where his body can go, such as up, down, forward, backward, sidewards, in a straight or curved path; and how his body can move, such as quickly, slowly, lightly, or in a heavy manner. The lesson revolves around a predetermined theme and within this theme the student seeks to reach an understanding of one or more of the above concepts. (85)

Followers of the functional theory of learning would probably support a problem-solving approach to learning both physical and non-physical activities.

Several studies have been undertaken which test the problem-solving approach, but few of these have been in the field of physical education.

Ray (76) found in a study comparing the directed study methods and the traditional teaching method that junior high school students taught by a directed-discovery method retained more material after six weeks than the other group. In word relationship tests Craig (55) tested two groups given different amounts of direction. One group was given the relationships and principles necessary for each word test, and the second group was made to figure these relationships out on their own. He found that the directed group learned more relationships and retained these principles better than the undirected group thirty-one days after testing was completed. Thus, pointing out the logical method of solving the tests aided the students both during and after testing.

Kirsh (18) taught three groups of high school students two novel arithmetic rules. One group had individual guidance in discovering the principles underlying the rules; a second group learned the rules by simple memorization; and a third group was taught by use of a programmed booklet. Kirsh concluded after six weeks that the groups using rote learning and guided discovery were better able to recall material than the group using the programmed book. A questionnaire given the students gave evidence that guided discovery encourages students to practice longer than the other two methods.

Smith (91) and LaPlante (89) both constructed studies comparing the problem-solving method and the traditional method of teaching bowling to college students. It was concluded in both studies that the differences in teaching methods were equally effective in teaching bowling and neither method was superior to the other.

Zeigler (92) conducted a study in gymnastics. One class was taught using the traditional method, and the other using the problem-solving approach. To test the results students were asked to create a routine which was judged on performance and quality of movement, and also to perform four stunts new to them. No differences were found between the groups in the quality of the performance or the skill level in the movement composition; but a significant difference in favor of the traditional method was found in the ability to learn new stunts after only one demonstration.

Thus, the teaching of physical education has progressed from a drill-type, teacher-centered, command-approach to the present day teacher-directed learning. The center or focus has shifted from the activity to the individual and from a strongly imposed discipline to self-discipline. Our aims have changed from mechanized teaching to treating of the individual as a thinking, creating, and rational person. As the aim and objectives of our society change, so do the educational purposes related so closely to the needs of our students in a democratic society.

CHAPTER IV

PROCEDURE

Selection of Subjects

Forty-nine freshman and sophomore students enrolled in two beginning gymnastic classes at the University of North Carolina at Greensboro were selected for this study. Due to withdrawals and absences, thirty-nine students completed the study. Subjects were selected from classes that met at approximately the same time of day. There were nineteen subjects in the experimental class which met Monday and Wednesday from 3:00 to 4:00 p.m., and twenty subjects in the control class which met Tuesday and Thursday from 4:00 to 5:00 p.m. The class taught by the traditional method--consisting of explanation, demonstration, and teacher-directed practice--was termed the control class. The experimental class was taught partially by the traditional method; but, in addition, the mechanical principles specific to each stunt were explained and applied to all stunts taught.

Experimental Conditions

Both classes met two times a week. The experiment was conducted over a period of four weeks. The experimental class was scheduled for the Monday-Wednesday sequence because it was felt that if the proposed lesson was not covered, due to the time element, the Tuesday-Thursday class could be changed accordingly. During the first class period the students of both groups were informed of the nature of the experiment and told they would be tested on twelve stunts the following lesson. Classes were informed that the test would consist of twelve beginning tumbling stunts and that the nature and names of these stunts would not be revealed until the time each individual would be called upon to perform. Subjects were asked to do the best they could and told that their class grade would not be influenced by the scores. At this time students were asked to fill out a card requesting knowledge of their previous experience in gymnastics. A copy of the card appears in the Appendices.

Selection of Stunts

Twelve stunts were selected on the basis of listings as beginning or basic stunts in gymnastic testbooks (2, 14, 24) and on the writer's previous experience with the degree of difficulty imposed by specific stunts. Any stunt solely dependent upon either flexibility or strength was not selected for the study. The twelve stunts included in the study were: (1) the forward roll; (2) backward roll; (3) dive forward roll;

(4) tripod; (5) headstand; (6) cartwheel; (7) straddle forward rolls; (8) straddle backward roll; (9) handstand; (10) drag-up headstand; (11) round-off; and (12) a handstand into a forward roll. A brief description of each stunt follows.

(1) <u>forward roll</u> - The hands are placed on the mat shoulder-width apart and the body is in a tucked position. The hips are raised high and the head is tucked as the body is pushed forward by the hands and feet. As the feet come to the floor the body is extended and a standing position is assumed.

(2) <u>backward roll</u> - The backward roll is begun in a squat position with the head tucked. The hands push against the mat and as the roll is initiated they are brought above the shoulders and used to push the body over. The legs are tucked throughout the entire stunt and as the feet hit the floor the legs are extended.

(3) <u>dive forward roll</u> - To perform the dive forward roll, a jump is initiated off both feet at the same time the body is slightly inclined forward. The weight is taken onto the arms which slowly bend as the head is tucked. The weight is taken off the arms and onto the back of the neck. A roll is completed and the stunt is finished in a standing position.

(5) <u>headstand</u> - To move into a headstand, the tripod is performed and then the body is shifted slightly forward as the legs are straightened and the back arched.

(6) <u>cartwheel</u> - The cartwheel will be explained as if being performed to the left. The left side of the body is facing the line of direction. The left foot is stepped on as the right foot is kicked upward. At the same time the left hand is placed on the mat, followed by the right hand and right foot. The stunt is completed as the left foot returns to the mat and the body is in an upright position. In this stunt the hands and feet are placed on an imaginary line.

(7) <u>straddle forward rolls</u> - To accomplish two straddle forward rolls, the legs are placed in a stride position. The body is piked at the hips as the head is tucked tightly and the weight is shifted onto the hands and neck. As the legs approach the ground the hands are placed between the legs, the hips raised, and the arms pushed forcibly against the mat to initiate the second roll.

(8) <u>straddle backward roll</u> - To perform a straddle backward roll, the same starting position is assumed as in the forward straddle roll. The weight is shifted onto the heels, and the upper body is brought forward as the seat hits the floor. Just before the body hits the mat the hands are placed

between the legs and the upper body is straightened to relieve the force of the fall. The feet remain in the straddle position as the hands push against the mat to initiate the stand.

(9) handstand - Both hands are brought down to the floor near the feet as one leg is forcibly brought upward. The head is kept up and the shoulders over the hands with the back slightly arched to assume a balanced handstand position.

(10) drag-up headstand - To begin the drag-up headstand, the forehead is placed on the mat, the hands placed to the sides and slightly in back of the shoulders with the body flat on the mat. The hips are piked as the straight legs are dragged in toward the hands and head. The weight is then shifted forward as the legs are raised off the mat to the vertical position. As the legs are raised the weight is shifted back and the back slightly arched to maintain a balanced headstand position.

(11) round-off - The round-off is started as if doing a cartwheel; but as the handstand position is reached, the legs are snapped together and a half twist is initiated at the hips. The hips are flexed forcibly throwing the legs toward the mat as the hands initiate the push.

(12) handstand into a forward roll - To complete this stunt, the handstand position is assumed. The body is slightly overbalanced as the arms are slowly bent and the head and legs are tucked to finish in a forward roll to a stand.

In addition to the twelve stunts used in the first testing situation, three new stunts were added for the retest. The headspring, shoot-through, and backward roll to a headstand were chosen because it was felt that none of the students were familiar with any of these three stunts and that these stunts were advanced enough that subjects would have to analyze body movements carefully and apply past knowledges to execute the stunts successfully. A description of these three stunts follows.

(1) headspring - The headspring was performed over a rolled mat to make it easier for the students. The head and hands are placed in a tripod position on the rolled mat. The hips are piked bringing the legs parallel to the floor. As this position is achieved the body weight is brought forward of the center of gravity and as balance is lost the legs are whipped forward and upward as the hands push against the mat. The stunt is finished in a squat position on the far side of the mat.

(2) shoot-through - In the shoot-through the starting position is similar to a push-up position. The student raises the hips and at the same time bends the knees up to the chest supporting the weight on the arms so the body can pass between the arms in this tucked position. The stunt is completed in a sitting position with the legs straight out in front and the trunk vertical.

(3) backward roll to a headstand - The roll is begun as previously stated. As the hands hit the mat the legs are forcibly extended upward, the back arched, and the hands moved far back of the head to change the rotary motion into linear motion and to slow the body movement down so a balanced headstand position may be achieved.

Administration of the First Test

The second meeting time of the class was used to administer the first test, which was designated as the pre-test. Each subject was given a number to facilitate rating and to make recording easier. Rosenthal Gymnasium was used for the testing, and a second room was used where subjects could wait their turn without observing others who were taking tests. Rating sheets had been prepared for each subject listing her number and each stunt to be used in the testing, a copy of which is included in the Appendices. Subjects were called into the gymnasium one at a time and asked to perform each stunt. Three raters were present, chosen on their knowledge of gymnastics and past teaching experience of this activity. Miss Dorothy Davis, one of the raters, has been teaching physical education at the University of North Carolina at Greensboro for the past thirty-seven years and has also taught gymnastics at this same institution. Misses Carolyn Callaway and Carol Williams, the other two raters, at the time of the study were completing graduate work at the University of North Carolina at Greensboro. Carolyn Callaway had previously taught physical education, in which gymnastics was included in the program, for three years at the secondary level. Carol Williams had taught physical education for thirteen years and gymnastics for the same number of years at the elementary, secondary, and college levels. Before testing began, the raters were shown the correct body positions for each stunt by the writer and common errors for which to look. Each rater was given a rating scale, a copy of which is included in the Appendices. Ratings were given on a five-point basis, five denoting an excellent score. No student was given aid in any stunt. If a subject did not know a stunt, she was not allowed to seek explanation either by verbal or visual means. Each subject was allowed to try her interpretation of the stunt. If this was correct she received the appropriate rating, but if her conception of a stunt was incorrect a score of zero was given by each of the raters. When one subject completed the twelve stunts the next subject was called into the gymnasium and asked to perform.

All forty-nine subjects were present for this pre-test. The administration of the tests were completed in one hour for each class.

Administration of the Retest

At the completion of three weeks of instruction a retest was given. Only forty-three subjects completed the second administration of the test. Six students were absent from the retest due to illness, and four students had to be dropped from the study because of absences--leaving thirty-nine subjects.

A loop film was made by the writer showing the execution of the three additional stunts used in the retest. The last lesson of the study, students were informed they would see a film demonstrating these stunts. No mention was made of the names of these stunts; therefore, subjects could not practice them. They were told they would watch the film a number of times and without practice perform each stunt in the best manner possible. When each class arrived the day of the retest, the loop film was viewed by the group seven times. Students were asked to watch each stunt for a general impression the first two times. The last five times they were to see how the stunt was performed and to imagine themselves doing it. The loop was made so that each stunt was performed once at normal speed and immediately after in slow motion. Thus, in one viewing of the entire loop, subjects saw a headspring at normal speed, a headspring in slow motion, a shoot-through at normal speed, a shoot-through in slow motion, a backward roll to a headstand at normal speed, and the same stunt in slow motion in the above order. After viewing the loop seven times each stunt was seen a total of fourteen times.

The film loops had been prepared with the use of a Bell & Howell Camera set at 16 frames per second for normal speed, and 48 frames per second for slow motion. The film used was 8mm TRI-X 25' black and white. In addition to the natural sunlight and overhead lights in Rosenthal Gymnasium, bar lights and one flood light were focused on the performer. The writer performed all three stunts in this sequence. This loop film may be seen by contacting the University of North Carolina at Greensboro, Department of Physical Education.

The first two and last two times the film was viewed, the names of each stunt were given; but aside from this there was no commentary or explanation. Test administration proceeded in the same manner as in the pre-test, the only variation being the addition of the three stunts previously mentioned. Stunts were performed in the same sequence as in the first administration of the test and after completion of the twelve stunts the three additional stunts were attempted.

Testing was completed within a two-hour period for each class. Because of the addition of the three stunts per person and because more subjects performed more stunts than in the pre-test, testing had to be lengthened by an additional sixty minutes.

Method of Instruction

Each lesson for each class began with exercises designed to develop strength, flexibility, coordination, and agility. The importance of safety was explained and spotting techniques were demonstrated in each lesson. The three basic body positions--the tuck, lay-out, and pike--were also demonstrated since this terminology was utilized throughout the lessons. Two or three stunts were presented each lesson--the same stunts for both classes. The stunts were presented in progression, and each student was encouraged to try a stunt if she had completed the previous stunt in progression with a fair degree of success. Because certain stunts depended upon successful completion of a previously taught stunt, students were asked to succeed in the first stunt before proceeding to the next.

For example, a student who could not do a cartwheel with a fair degree of success practiced this stunt before attempting a round-off. This practice was followed in order to insure subsequent success as well as to insure safety measures.

Each stunt was demonstrated by the writer and an explanation was given. Spotting techniques were also demonstrated and any questions pertaining to the stunt were answered. The class taught a mechanical understanding of the stunts, the experimental class, was also taught by the traditional method of demonstration, explanation, and teacher-directed practice. Any mechanical principles applicable to the stunt were explained and then applied to each stunt as it was taught. Thus, in a forward roll, students were told they must tuck their heads and legs to shorten the radius of rotation and that this would make them rotate faster and more smoothly. This principle was then applied to an ice-skater who brings her arms in tightly toward her body while executing a spin to increase her rotation and subsequently brings her arms away from her body to slow her spin down. The same principle was applied to a trampoline performer who tightly tucks in a forward somersault and then "open-up" thus lengthening the radius of rotation to slow the speed down to facilitate landing in a balanced standing position on the trampoline bed. Examples were chosen with which it was thought the majority of the class would be familiar. For the balance stunts, the tripod, headstand, and handstand principles were applied to equilibrium and balance. It was explained to the students in this experimental class why a wide base of support was easier to use and why it was easier to balance when the center of gravity was over the base of support and this base of support was low. Each stunt was taught individually, and these principles were applied to each at the proper time. Thus, the difference in the degree of difficulty between a tripod, headstand, and handstand could be comprehended by each student in this class.

This approach was used in all lessons taught to the experimental class; and questions were asked by the writer to make sure students understood not only how to perform a stunt, but why it was necessary to perform it in this manner. The above are only a few examples of the methods used, but the same technique was applied to all twelve stunts. A listing of the mechanical principles taught will be found in the Lesson Plans in the Appendices.

No mention of any principles was given the class taught by the traditional method only. The lessons thus consisted of (1) exercises; (2) explanation; (3) demonstration;

(4) teacher-directed practice of new stunts; and (5) a five-minute "open" practice period in which students could practice any skills previously learned, as well as the stunts introduced in that particular lesson.

Summary

Judges' ratings were used to measure the initial and final tumbling skill of subjects in two beginning gymnastic classes. One class was taught the twelve stunts using the traditional approach of explanation, demonstration, and teacher-directed practice. The second class, the experimental group, was taught the same twelve stunts using the traditional method of teaching, as well as explaining the mechanical principles applicable to each stunt.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA

It was the purpose of this study to investigate the difference in the improvement level of students in learning specific beginning tumbling stunts over a period of four weeks under two differing methods of instruction. The study was conducted to determine whether a traditional teaching approach as contrasted to traditional teaching approach with the addition of one variable, an understanding of the mechanical principles governing the stunts, differed with regard to learning.

Subjects for this study were thirty-nine college freshman and sophomore women enrolled in two beginning gymnastic classes at the University of North Carolina at Greensboro. The experimental method involved the addition of one factor to the traditional method of explanation, demonstration, and practice. This factor was defined as an understanding of the mechanics of movement. Ratings for each subject on each of twelve stunts were determined by three raters prior to instruction, and a mean score was determined for each subject for each stunt. Teaching was conducted over a three-week period.

After three weeks of instruction the subjects were retested by the same raters and mean scores were obtained for each subject on each stunt. Raw scores for all subjects are presented in the Appendices.

A series of null hypotheses was formulated and a significance of difference at the five percent level of confidence or above was considered an acceptable standard at which to reject the hypothesis. The null hypotheses are presented here in terms of:

a. differences between groups on the pre-test scores;

b. differences within a group on the pre-test and post-test scores;

c. differences in the skill improvement between the pre-test and post-test scores between the two groups;

d. differences between groups on the post-test scores;

e. differences between groups on the scores of the three extra stunts.

Differences between Groups on Pre-test Scores

The writer was interested in knowing if there was any statistical difference between the two groups at the beginning of the experiment.

The first null hypothesis stated that:

There is no significant difference in the initial skill level in tumbling ability as indicated by the pre-test scores between the experimental and control groups.

An analysis of variance technique was used to determine if there was a statistical difference between the control class and the experimental class on the pre-test scores of all students for all twelve stunts.

No significant difference was found between the mean scores of subjects in the experimental class as compared to those in the control class. A significant statistical difference was found among stunts in the experimental class as compared to stunts in the control class. This hypothesis was found untenable at the one percent level of confidence. These results appear in Table I, page 54.

Fisher's "t" test of significance between uncorrelated means was used to determine where this difference between stunts was significant. It was found that there was a significant difference at the five percent level of confidence between groups on the pre-test scores on the dive forward roll, in favor of the experimental group, but that no other stunts showed a significant difference. These results appear in Table II, page 55.

The second null hypothesis stated that:

There is no significant difference of scores received on the Scott General Motor Ability Test between subjects in

TABLE I

ANALYSIS OF VARIANCE OF PRE-TEST SCORES FOR THE CONTROL GROUP AND THE EXPERIMENTAL GROUP

SOURCE OF VARIANCE	SUM OF SQUARES	df	MEAN SQUARE	F
Between groups	2.7	1	2.7	2.37
Between stunts	383.08	11	34.8	30.6*
Within groups	505.97	444	1.139	
Interaction	9.84	11	.89	.8
TOTAL		467		

*Significant at the .01 level of confidence.

TABLE II

MEANS AND SIGNIFICANCE OF DIFFERENCE AMONG THE EXPERIMENTAL GROUP AND CONTROL GROUP ON THE PRE-TEST ON EACH OF THE TWELVE STUNTS

	EXPERIMENTAL GROUP		CONTROL GROUP		
STUNTS	N	M	N	M	"t"
Forward Roll	19	2.56	20	2.33	.765
Dive Roll	19	1.12	20	.335	2.186*
Backward Roll	19	1.39	20	1.68	.928
Tripod	19	2.54	20	2.38	.252
Headstand	19	1.88	20	1.73	.276
Cartwheel	19	1.88	20	1.51	.987
Straddle Forward Roll	19	.226	20	0	1.64
Straddle Backward Roll	19	0	20	0	0
Drag-Up Headstand	19	.179	20	.430	.905
Handstand	19	.921	20	.72	.602
Round-Off	19	.174	20	0	1.35
Handstand into a Forward Roll	19	0	20	.15	1.0

*Significant at the .05 level of confidence.

the experimental group and subjects in the control group.

Fisher's "t" test of significance between uncorrelated means was used to determine if there was any statistical difference. The hypothesis was accepted as tenable since no significant difference was found between the two groups. These results appear in Table III, page 57.

Differences within a Group on the Pre-test and Post-test Scores

The writer was interested in knowing if there was any statistical difference within each group between the first and final administration of the skills test.

The third null hypothesis stated that:

There is no significant difference within the experimental group on scores of the initial and final tests between subjects and between stunts.

An analysis of variance technique was used to determine if this group improved significantly. The hypothesis was found untenable at the one percent level of confidence. These results appear in Table IV, page 57.

Fisher's "t" test of significance between correlated means was used to determine the change in skill level between the first and final administrations of the test for each stunt for the experimental group.

TABLE III

MEAN AND SIGNIFICANCE OF DIFFERENCE AMONG THE EXPERIMENTAL AND CONTROL GROUPS ON THE SCOTT GENERAL MOTOR ABILITY TEST

GROUP	N	M	"t"
Experimental	19	57.3	.48
Control	20	56.4	

TABLE IV

ANALYSIS OF VARIANCE OF THE EXPERIMENTAL GROUP BETWEEN THE PRE-TEST AND POST-TEST SCORES

SOURCE OF VARIANCE	SUM OF SQUARES	df	MEAN SQUARES	F
Between trials	601.9	23	26.2	31 *
Between subjects	130.9	18	7.3	8.69*
Interaction	349.2	414	.84	
TOTAL		455		

*Significant at the .01 level of confidence.

The null hypothesis was found untenable and was rejected at the one percent level of confidence for each of the twelve stunts. These results appear in Table V, page 59.

Fisher's "t" test between correlated means was used to determine the change in skill level between the first and final administrations of the tests for all subjects.

The null hypothesis was found untenable and was rejected at the one percent level of confidence for all subjects in this experimental group. These results appear in Table VI, page 60.

The fourth null hypothesis stated that:

There is no significant difference within the control group on scores of the initial and final tests between subjects and between stunts.

An analysis of variance was used to determine if this group improved significantly. The hypothesis was found untenable at the one percent level of confidence. These results appear in Table VII, page 60.

Fisher's "t" test between correlated means was used to determine the change in skill level between the first and final administrations of the test for each stunt.

The null hypothesis was found untenable and rejected at the one percent level of confidence for each of the twelve stunts. These results appear in Table VIII, page 61.

TABLE V

SIGNIFICANCE OF DIFFERENCE OF MEAN CHANGES BETWEEN THE PRE-TEST AND POST-TEST SCORES WITHIN THE EXPERIMENTAL GROUP

STUNT	N	D	"t"
Forward Roll	19	.81	4.33*
Dive Roll	19	1.7	5.46*
Backward Roll	19	1.35	9.45*
Tripod	19	1.93	5.67*
Headstand	19	1.26	4.85*
Cartwheel	19	.684	3.95*
Straddle Forward Roll	19	1.96	8.76*
Straddle Backward Roll	19	2.53	8.78*
Drag-Up Headstand	19	1.45	4.57*
Handstand	19	1.33	6.82*
Round-Off	19	1.74	6.55*
Handstand Forward Roll	19	1.73	5.26*

*Significant at the .01 level of confidence.

TABLE VI

SIGNIFICANCE OF DIFFERENCE OF MEAN CHANGES BETWEEN THE PRE-TEST AND POST-TEST SCORES OF ALL SUBJECTS IN THE EXPERIMENTAL GROUP AND IN THE CONTROL GROUP

GROUP	N	D	"t"
Experimental Class	19	18	16.8*
Control Class	20	18.6	17 *

*Significant at the .01 level of confidence.

TABLE VII

ANALYSIS OF VARIANCE WITHIN THE CONTROL GROUP BETWEEN THE PRE-TEST AND POST-TEST SCORES

SOURCE OF VARIANCE	SUM OF SQUARES	df	MEAN SQUARE	F
Between trials	685.9	23	29.8	32.1*
Between subjects	143.9	19	7.57	8.16*
Interaction	405.2	437	.927	
TOTAL		479		

*Significant at the .01 level of confidence.

TABLE VIII

SIGNIFICANCE OF DIFFERENCE OF MEAN CHANGES BETWEEN THE PRE-TEST AND POST-TEST SCORES WITHIN THE CONTROL GROUP ON EACH OF THE TWELVE STUNTS

STUNT	N	D	"t"
Forward Roll	20	.81	4.54*
Dive Roll	20	2.65	11.4 *
Backward Roll	20	1.17	7.11*
Tripod	20	2.17	5.47*
Headstand	20	1.56	4.64*
Cartwheel	20	.79	5.09*
Straddle Forward Roll	20	2.08	11.69*
Straddle Backward Roll	20	2.61	9.79*
Drag-Up Headstand	20	1.18	3.84*
Handstand	20	1.41	5.66*
Round-Off	20	.975	3.27*
Handstand Forward Roll	20	1.15	3.58*

*Significant at the .01 level of confidence

Fisher's "t" test between correlated means was used to determine the change in skill level between the first and final administrations of the tests for all subjects.

The null hypothesis was found untenable and was rejected at the one percent level for all subjects in this control group. These results appear in Table VI, page 60.

Differences in the Skill Improvement between the Pre-test and Post-test Scores between the Two Groups

It was of interest to the writer to find out if one group improved significantly more than the other group between the administrations of the pre- and post-tests.

The fifth null hypothesis stated that:

There is no significant difference between the improvement scores from pre-test to post-test between groups. The improvement scores were determined by subtracting the pre-test scores from the post-test scores.

An analysis of variance technique was used to determine if there was a greater improvement in either group and in any of the stunts between an initial and final testing period.

No significant differences were found between the scores of the two groups nor between stunts and the null hypothesis was accepted as tenable. Results of these data appear in Table IX, page 63.

TABLE IX

ANALYSIS OF VARIANCE BETWEEN THE IMPROVEMENT FROM PRE-TEST TO POST-TEST BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS

SOURCE OF VARIANCE	SUM OF SQUARES	df	MEAN SQUARE	F
Between Groups	.2	1	.2	.146
Between Stunts	127.8	11	11.7	.85
Within Groups	606.6	444	1.37	
Interaction	24.4	11	2.2	1.6
TOTAL	759	467		

<u>Differences between Groups on the Post-test Scores</u>

The writer was interested in knowing if there was any statistical difference between the two groups at the end of the experiment as measured by the post-test.

The sixth null hypothesis stated that:

There is no difference on the final skill level between the experimental group and the control group as indicated by the post-test scores.

An analysis of variance technique was used to determine if there was a significant difference between scores of classes taught by two differing methods after three weeks of instruction.

No statistical difference was found between the mean scores of the two groups. A statistical difference among stunts was found by use of the analysis of variance. These results appear in Table X, page 65.

Fisher's "t" test of significance between uncorrelated means was used to determine where the difference between stunts was significant. It was found that there was a significance of difference between the two groups in favor of the experimental on the forward roll and round-off, but that no other stunts showed a significant difference between groups. These results appear in Table XI, page 66.

TABLE X

ANALYSIS OF VARIANCE OF POST-TEST SCORES BETWEEN THE CONTROL AND THE EXPERIMENTAL GROUPS

SOURCE OF VARIANCE	SUM OF SQUARES	df	MEAN SQUARE	F
Between groups	0	1	0	0
Between stunts	320.3	11	29.18	24.7*
Within groups	524.6	444	1.18	
Interaction	22.58	11	2.05	1
TOTAL		467		

*Significant at the .01 level of confidence.

TABLE XI

MEAN AND SIGNIFICANCE OF DIFFERENCE AMONG THE EXPERIMENTAL GROUP AND CONTROL GROUP ON THE POST-TEST FOR EACH OF THE TWELVE STUNTS

STUNTS	EXPERIMENTAL GROUP N	EXPERIMENTAL GROUP M	CONTROL GROUP N	CONTROL GROUP M	"t"
Forward Roll	19	3.37	20	3.14	2.05*
Dive Roll	19	2.83	20	3.00	.627
Backward Roll	19	2.75	20	2.86	.472
Tripod	19	4.47	20	4.55	.408
Headstand	19	3.11	20	3.28	.478
Cartwheel	19	2.66	20	2.29	.916
Straddle Forward Roll	19	2.19	20	2.08	.442
Straddle Backward Roll	19	2.53	20	2.61	.204
Drag-Up Headstand	19	1.63	20	1.62	.0197
Handstand	19	2.25	20	2.13	.359
Round-Off	19	1.86	20	.975	2.04*
Handstand into a Forward Roll	19	1.73	20	1.30	.917

*Significant at the .05 level of confidence.

<u>Differences between Groups on the Scores of the Three Extra Stunts</u>

The writer was interested in knowing if either group was able to learn stunts more efficiently that had neither been explained nor practiced.

The seventh null hypothesis stated that:

There is no significant difference between the experimental and control classes on the mean scores of the three extra stunts tested at the time of the retest.

Fisher's "t" test of significance of difference between uncorrelated means was used to determine the difference between the ability of both classes to perform these three stunts with no previous explanation or practice.

No significant difference was found between the mean scores of the subjects on each of the three stunts and the hypothesis was accepted as tenable. Results of this data appear in Table XII, page 68.

<u>Interpretation of Data</u>

Fisher's "t" test of significance between uncorrelated means showed that the experimental group and control group were equated at the beginning of the experiment in relation to tumbling ability and general motor ability. The only variation in this was the statistical difference of the experimental

TABLE XII

MEAN AND SIGNIFICANCE OF DIFFERENCE AMONG THE EXPERIMENTAL AND CONTROL GROUPS ON THE THREE EXTRA STUNTS ADMINISTERED IN THE POST-TEST

STUNTS	EXPERIMENTAL GROUP N	EXPERIMENTAL GROUP M	CONTROL GROUP N	CONTROL GROUP M	"t"
Headspring	19	1.34	20	.950	1.399
Shoot-Through	19	1.99	20	1.77	.841
Backward Roll to a Headstand	19	.521	20	.60	.412

group in one stunt, the dive forward roll. There seems to be no logical explanation for this.

The fact that classes were alike in their initial tumbling skill might have been anticipated, as students in these classes chose to elect a course in beginning gymnastics. Students electing a gymnastic course would be expected to have a similar amount of skill potential in tumbling stunts and desire to improve their potential. The students in the two classes could also be expected to have some knowledge of their strength, coordination, and agility, and to be aware of the necessity of these attributes in successful completion of the gymnastic course. Therefore, students electing a beginning gymnastic course might be similar in their general motor ability, as measured by the Scott General Motor Ability Test.

The testing results indicated that the improvement of the groups between the initial and final testing periods was not significantly different. The statistical evidence does show that each group taken separately improved between the time of the initial and final testing. This evidence would suggest that, although the individual groups improved between the pre-test and post-test, the improvement of both groups was similar and that neither group improved more than the other. Within each group a statistical difference was found between each subject and each of the twelve stunts tested suggesting that learning takes place regardless of a knowledge of the mechanical principles pertaining to the stunts. Thus, instruction concerning the mechanical principles utilized in the performance of certain tumbling stunts does not facilitate learning of those skills to any greater extent than an equal amount of time spent in practice of the same stunts.

These results are in agreement with Zuber (93), Colville (88), and Cobane (87), who found that an understanding of mechanical principles did not facilitate learning of specific motor skills. In contrast to these findings, Barrett (86) found that a group taught to understand the mechanical principles governing four selected swimming strokes learned faster and better than a group taught in the traditional method without an understanding of these same principles. The contrast in the above findings could suggest that an understanding of mechanical principles in specific motor skills is ineffective in facilitating learning in skills where the body is in a medium other than water. The principles governing force and propulsion of a body in water may be new to the subject, especially at the beginning level, and therefore more effective in learning.

The fact that the experimental group changed to a greater extent than the control group, as shown in the post-test scores, on two stunts--the forward roll and round-off--suggests that the controlled variable of teaching instruction might have been responsible for this change. By gaining an understanding of certain mechanical principles the experimental group may have been able to succeed faster than the control group, or the success of the experimental group might have reflected unmeasured psychological factors.

In comparing mean scores of the experimental and control groups in relation to the skill level on the three extra stunts--the headspring, the shoot-through, and the backward roll to a headstand--no significant differences were found. It appears from this evidence that an understanding of the mechanical principles pertaining to basic tumbling stunts was not applied by the subjects in the experimental group to any greater extent than subjects in the control group on these more difficult stunts. Although both groups were able to perform these stunts, not having previously practiced them and having received no instruction, neither group was superior to the other.

Thus, knowledge of the mechanics governing these tumbling stunts does not seem to facilitate subsequent learning as evidenced by the performance of a similar more difficult stunt. It may be that an intellectual understanding of principles applicable to basic tumbling stunts is understood by the subjects, but the ability to apply these principles is dependent upon physical capabilities and limitations. If a student has a knowledge and understanding of the principles applicable to the stunts, she may know exactly what is to be done and the rationale behind this, but still is unable to accomplish the feat.

In conclusion it would appear that students taught a mechanical understanding of specific tumbling skills improved as much as students taught without an understanding of these principles, despite a loss in practice time.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the difference in the improvement level of students in learning specific beginning tumbling stunts over a period of four weeks under two differing methods of instruction. The study was conducted to determine whether a traditional approach with regard to teaching methodology as constrasted to a traditional approach with the addition of one variable, an understanding of the mechanical principles governing the stunts, differed with regard to learning.

Subjects were thirty-nine college freshman and sophomore women enrolled in two beginning gymnastic classes at the University of North Carolina at Greensboro. The experimental method involved the addition of one factor to the traditional method of explanation, demonstration, and practice. This factor was defined as an understanding of the mechanics of movement involved in the selected stunts taught. Ratings for each subject on each of the twelve beginning tumbling stunts were determined for each subject for each stunt. The experimental teaching situation and the traditional teaching situation were conducted over a three-week period.

After three weeks of instruction the subjects were re-tested by the same raters and mean scores were obtained for each subject on each stunt. Three additional stunts were tested at this time. These additional stunts were viewed by subjects on a loop film. No other explanations with regard to the three new stunts were given.

Data were treated statistically, (1) to determine any differences in the tumbling skill level of the two groups at the beginning of the study; (2) to determine any differences between the two groups in general motor ability; (3) to determine if improvement in tumbling skill occurred within each group from the beginning to the end of the study; (4) to determine if there was a difference in the improvement level of tumbling skill between the two groups from the beginning to the end of the study; (5) to determine if there was a difference in the tumbling skill between the two groups at the end of the study; and (6) to determine if there was a difference in the skill level between the groups on the performance of three additional stunts.

A series of null hypotheses was formulated regarding differences between and within groups. An analysis of variance technique and Fisher's "t" tests for the significance of difference between both correlated and uncorrelated means were the statistical methods used for treating the data.

The following results were obtained:

1. There was no significant statistical difference in the initial tumbling skill of subjects in the two groups at the beginning of the study.

2. There was no significant statistical difference in the general motor ability scores of subjects in the two groups as measured by the Scott Motor Ability Test.

3. A difference, significant at the five percent level of confidence, was found on the initial test scores between the two groups on one stunt--the dive forward roll--in favor of the experimental group. No other significant differences were found between the groups on any other stunts.

4. There was a change, significant at the one percent level of statistical confidence, in the improvement in tumbling skill from beginning to end of the study within each class for all subjects.

5. There was a statistical difference significant at the one percent level of confidence within each class from the beginning to the end of the study on each of the twelve stunts.

6. There was no significant statistical difference between the two groups in the amount of skill improvement from beginning to end of the study.

7. There was no statistical difference between the two groups on the final skill level of all subjects.

8. There was a statistical difference significant at the five percent level of confidence in favor of the experimental group at the end of the study on the forward roll and round-off. No other significant differences were found between the two groups on any other stunts.

9. There was no statistical difference between the two groups on the mean scores of the three additional stunts tested at the time of the retest.

The findings of the present study resulted in the following conclusions:

1. Both the traditional approach and the traditional approach with an emphasis on mechanical principles applicable to the twelve stunts taught resulted in improvement in tumbling skill for all subjects.

2. Both the traditional approach and the traditional approach with an emphasis on mechanical principles resulted in improvement in tumbling skill in each of the twelve stunts taught.

3. Neither teaching approach was more effective in the improvement of tumbling skill from the beginning to the end of the study. Instruction concerning the mechanical principles utilized in the performance of certain stunts did not facilitate learning of those stunts between the initial and final testing period.

4. Neither teaching approach proved more effective than the other in the improvement of students on any of the twelve stunts taught.

5. Neither teaching approach proved to be more effective than the other in the final tumbling skill of all subjects.

6. The traditional teaching approach with an emphasis on mechanical principles applicable to the tumbling stunts taught proved more effective than the traditional teaching approach in the final skill level of students on two stunts--the forward roll and round-off.

7. Neither group was able to learn three stunts, that had neither been practiced nor explained, more effectively than the other group. There was no reason to believe that an understanding of the mechanical principles pertaining to basic tumbling stunts was applied by subjects in one group to any greater extent than by subjects in the other group.

Recommendations

1. The final testing should be scheduled for a two-hour period. Half the students should be asked to come the first hour and view the loop film, and the other half should be asked to come the beginning of the second hour to view the loop film and be tested immediately after.

2. Students should be tested on their application of mechanical principles in ways other than tumbling stunts. They might be asked to perform skills that exemplify an understanding of the principles of equilibrium, force, and motion, independent of tumbling stunts. Groups would be tested and results compared to see if a knowledge of mechanical principles could be applied in differing situations.

3. The study could be expanded by teaching a third group, using the problem-solving approach to gymnastics, with the addition of an understanding of the mechanics of movement as applied to tumbling stunts.

4. The rate of learning-selected tumbling stunts should be investigated to ascertain any differences in the speed of learning between groups taught by two differing methods of instruction.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

1. Anderson, Lester G., and Arthur Gates. "The General Nature of Learning." Learning and Instruction. Forty-Ninth Yearbook of the National Society for the Study of Education, Part I. 12-35pp. Chicago: University of Chicago Press, 1950.

2. Baley, James A. Gymnastics in the Schools. Boston: Allyn and Bacon, Inc., 1965. 297pp.

3. Barnes, Mildred, and Margaret Fox, Pauline Loeffler, and Gladys Scott. Sports Activities for Girls and Women. New York: Appleton Century Crofts, 1966. 462pp.

4. Bjorksten, Elli. Principles of Gymnastics for Women and Girls. London: J. A. Churchill Ltd., 1937. 603pp.

5. Broer, Marion R. Efficiency of Human Movement. Philadelphia: W. B. Saunders Company, 1960. 342pp.

6. Brown, Camille, and Rosalind Cassidy. Theory in Physical Education: A Guide to Program Change. Philadelphia: Lea and Febiger, 1963. 244pp.

7. Brownell, Clifford, and Patricia Hagman. Physical Education Foundations and Principles. New York: McGraw-Hill Book Company, 1951. 397pp.

8. Bucher, Charles. Foundations of Physical Education. St. Louis: C. V. Mosby Company, 1960. 492pp.

9. ________, Constance Koenig, and Milton Barnhard. Methods and Materials for Secondary School Physical Education. St. Louis: C. V. Mosby Company, 1965. 458pp.

10. Bukh, Niels. Fundamental Gymnastics. New York: E. P. Dutton and Company, 1928. 202pp.

11. Bunn, John W. Scientific Principles of Coaching. New York: Prentice-Hall Company, Inc., 1955. 201pp.

12. Carlquist, Maja. Rhythmical Gymnastics. London: Methuen and Company, 1955. 186pp.

13. Cooper, John, and Ruth Glassow. Kinesiology. St. Louis: C. V. Mosby Company, 1963. 310pp.

14. Cotteral, Bonnie, and Donnie Cotteral. The Teaching of Stunts and Tumbling. New York: A. S. Barnes and Company, 1936. 337pp.

15. Cratty, Bryant J. Movement Behavior and Motor Learning. Philadelphia: Lea and Febiger, 1964. 332pp.

16. Cronbach, Lee J. Educational Psychology. New York: Harcourt, Brace, and World Inc., 1954. 628pp.

17. Davis, Elwood, and John Lawther. Successful Teaching in Physical Education. New York: Prentice-Hall Inc., 1948. 617pp.

18. ________, and Earl Wallis. Toward Better Teaching in Physical Education. New Jersey: Prentice-Hall Inc., 1961. 488pp.

19. Drury, Blanche, and Andrea Schmid. Gymnastics for Women. California: The National Press, 1965. 204pp.

20. Frederick, Bruce. Women's Gymnastics. Iowa: Wm. C. Brown Company, 1966. 81pp.

21. Halsey, Elizabeth. Inquiry and Invention in Physical Education. Philadelphia: Lea and Febiger, 1964. 119pp.

22. Hartman, George. "The Field Theory of Learning and its Educational Consequences." The Psychology of Learning. Forty-First Yearbook of the National Society for the Study of Education, Part II. Indiana: P. S. Publishing Company, 1942.

23. Hetherington, Clark W. School Program in Physical Education. New York: World Book Company, 1922. 132pp.

24. Hughs, Eric. Gymnastics for Girls. New York: Ronald Press Company, 1963. 268pp.

25. Johnson, Barry L. A Beginner's Book of Gymnastics. New York: Appelton-Century Crofts, 1966. 121pp.

26. Johnson, Granville Jr. "Motor Learning." Science and Medicine of Exercise and Sports. Edited by Warren Johnson 600-619pp. New York: Harper and Brothers, 1960.

27. Knudsen, Knud A. A Textbook of Gymnastics. Philadelphia: J. B. Lippencott Company, 1920. 347pp.

28. Kozman, Hilda C., Rosalind Cassidy, and Chester Jackson. Methods in Physical Education. Philadelphia: W. B. Saunders Company, 1947. 552pp.

29. Mauldon E., and J. Layson. Teaching Gymnastics. London: Macdonald and Evans Ltd., 1965. 192pp.

30. McCloy, C. H. "The Mechanical Analysis of Motor Skills." Science and Medicine of Exercise and Sports. Edited by Warren Johnson 54-64pp. New York: Harper and Row, 1960.

31. Mosston, Muska. Teaching Physical Education. Ohio: Charles E. Merrill Books Inc., 1966. 238pp.

32. Niemeyer, Roy K. "Part Against Whole Methods and Massed Versus Distributed Practice in the Learning of Selected Large Muscle Activities." Proceeds of the College Physical Education Association, 1958.

33. Pallett, Doreen. Modern Educational Gymnastics. Oxford: Pergamon Press, 1965. 137pp.

34. Ragsdale, Clarence E. "How Children Learn the Motor Types of Activities." Learning and Instruction. Forty-Ninth Yearbook of the National Society for the Study of Education, Part I. 69-91pp. Chicago: University of Chicago Press, 1950.

35. Rasch, Phillip, and Roger Burke. Kinesiology and Applied Anatomy. Philadelphia: Lea and Febiger, 1959. 443pp.

36. Scott, Gladys M. Analysis of Human Motion. New York: Appleton Century Crofts, 1963. 437pp.

37. Sharman, Jackson R. The Teaching of Physical Education. New York: A. S. Barnes and Company, 1936. 237pp.

38. Skarstrom, William. Gymnastic Teaching. Massachusetts: American Physical Education Association, 1921. 142pp.

39. Souder, Marjorie, and Phyllis Hill. Basic Movement. New York: Ronald Press Company, 1965. 157pp.

40. Stanley, Dennis, and I. F. Waglow. Physical Education Activities Handbook. Boston: Allyn and Bacon Inc., 1966. 236pp.

41. Thorndike, Robert L. "How Children Learn the Principles and Techniques of Problem Solving." Learning and Instruction. Forty-Ninth Yearbook of the National Society for the Study of Education, Part I. 192-215pp. Chicago: University of Chicago Press, 1950. 352pp.

42. Thorpe, Louis, and Allen Schmuller. Contemporary Theories Theories of Learning. New York: Ronald Press Company, 1954. 480pp.

43. Van Dalen, Deobold, Elmer Mitchell, and Bruce Bennett. A World History of Physical Education. New York: Prentice-Hall, 1953. 640pp.

44. Wells, Katherine F. Kinesiology. Philadelphia: W. B. Saunders Company, 1966. 554pp.

45. Williams, Marian, and Herbert Lissner. Biomechanics of Human Motion. Philadelphia: W. B. Saunders Company, 1962. 147pp.

46. Wood, Thomas D., and Rosalind Cassidy. The New Physical Education. New York: The Macmillan Company, 1927. 457pp.

B. PERIDOCIALS

47. Alley, L. E. "Utilization of Mechanics in Physical Education and Athletics," The Journal of Health, Physical Education and Recreation, 37:67-70, March, 1966.

48. Baley, James. "Beginning Tumbling Stunts," Athletic Journal, 44:8-18, December, 1963.

49. Barton, J. W. "Comprehensive Units in Learning Typewriting," Psychological Monographs, 25: No. 164, 1926.

50. Bell, H. M. "Retention of Pursuit Rotor Skills after One Year," Journal of Experimental Psychology, 40:648-649, October, 1950.

51. Braden, S. R. "An Extensive Experiment in Motor Learning and Relearning," The Journal of Educational Psychology, 15:313-315, December, 1924.

52. Briggs, Francis. "Problem-Centered Approaches to Teaching," High School Journal, 46:196-204, March 1963.

53. Bruner, J. S. "The Act of Discovery," Harvard Educational Review, 31:21-32, Winter, 1961.

54. Clein, M. I. "Mechanical Analysis: An Aid in Learning and Teaching Gymnastic Skills," The Journal of Health, Physical Education and Recreation, 38:67-68, January, 1967.

55. Craig, Robert. "Directed Versus Independent Discovery of Established Relations," The Journal of Educational Psychology, 47:222-234, April, 1956.

56. Cross, Thomas. "A Comparison of the Whole Method, the Minor Game Method, and the Whole Part Method of Teaching Basketball to Ninth Grade Boys," The Research Quarterly, 8:49-54, December, 1937.

57. Cureton, Thomas. "Elementary Principles and Techniques of Cinematographic Analysis as Aids to Athletic Research," The Research Quarterly, 10:3, May, 1939.

58. ________. "Physics Applied to Physical Education," The Journal of Health, Physical Education, and Recreation, 3:23-25, January, 1932.

59. Daugherty, G. "The Effects of Kinesiological Teaching on the Performance of Junior High School Boys," The Research Quarterly, 16:26-33, March, 1945.

60. Deach, Dorothy. "The Challenge of Movement Education," The Physical Educator, 18:92-93, October, 1961.

61. Gillette, Annette. "Learning and Retention," Archives of Psychology, 198:1-56, April, 1936.

62. Greenspoon, Joel, and Sally Foreman. "Effects of Delay of Knowledge of Results on Learning a Motor Task," Journal of Experimental Psychology, 51:226-228, March, 1956.

63. Gross, Richard. "Problem Solving: What It Isn't and What It Is," California Journal of Secondary Education, 31: 108-112, February, 1956.

64. Hendrickson, G., and W. H. Schroeder. "Transfer of Training in Learning to Hit a Submerged Target," The Journal of Educational Psychology, 32:205-213, March, 1941.

65. Hildreth, Gertrude. "Puzzle Solving with and without Understanding," The Journal of Educational Psychology, 33:595-604, November, 1942.

66. Hill, L. B. "A Second Quarter Century of Delayed Recall or Relearning at Eighty," The Journal of Educational Psychology, 48:65-68, January, 195 .

67. Judd, Charles H. "Special Training and General Intelligence," Educational Review, 36:38-42, 1908.

68. Kirsh, Bert Y. "The Motivating Effect of Learning by Directed Discovery," The Journal of Educational Psychology, 53:65-71, April, 1962.

69. Knapp, Clyde G., and Robert Dixon. "Learning to Juggle: A Study to Determine the Effect of Two Different Distributions of Practice on Learning Efficiency," The Research Quarterly, 21:331-336, October, 1950.

70. ________. "Learning to Juggle: A Study of the Whole and Part Methods," The Research Quarterly, 23:398-401, December, 1952.

71. Lawther, John. "Directing Motor Skill Learning," Quest, VI, 68-75, May, 1966.

72. Lockhart, Aileen. "Communicating with the Learner," Quest, VI, 57-67, May, 1966.

73. Ludwig, Eliza. "Basic Movement Education in England," The Journal of Health, Physical Education, and Recreation, 32:18-19, December, 1961.

74. Prater, Bette L. "Improving the Product," The Journal of Health, Physical Education and Recreation, 32:24-25, April, 1961.

75. Purdy, Bonnie J., and Aileen Lockhart. "Retention and Relearning of Gross Motor Skills after Long Periods of No Practice," The Research Quarterly, 33:265-272, May, 1962.

76. Ray, Willis E. "Pupil Discovery Versus Directed Instruction," Journal of Experimental Education, 29:271-280, March, 1961.

77. Ruger, Henry A. "The Psychology of Efficiency," Archives of Psychology, 2:1-88, 1910.

78. Saltzman, I. J. "Delay of Reward and Human Verbal Learning," Journal of Experimental Psychology, 41:437-439, June, 1951.

79. Scofield, Robert. "A Creative Climate," Educational Leadership, 18:5-6, October, 1960.

80. Shay, Clayton. "Part Versus Whole Methods of Learning in Gymnastics," The Research Quarterly, 5:62-67. December, 1934.

81. Torrence, Paul. "Seven Guides to Creativity," The Journal of Health, Physical Education and Recreation, 36:26-27, April, 1965.

82. Wickstrom, R. L. "Comparative Study of Methodology for Teaching Gymnastics," The Research Quarterly, 29:109-114, March, 1958.

83. Young, Olive. "Rate of Learning in Relation to Spacing of Practice Periods in Archery and Badminton," The Research Quarterly, 25:231-243, May, 1954.

C. UNPUBLISHED MATERIALS

84. Barrett, Kate R. "An Analysis of Exploration as a Method for Teaching Movement." Unpublished Master's thesis, University of Wisconsin, Madison, 1964.

85. ________. Mimeographed notes for a workshop presented at Boston University, Boston, Mass., December, 1961.

86. Barrett, Mildred E. "A Study of the Effects of a Knowledge of Mechanical Principles on Learning to Perform Specific Swimming Strokes." Unpublished Master's thesis, University of Maryland, College Park, 1959.

87. Cobane, Edith. "A Comparison of Two Methods of Teaching Selected Motor Skills." Unpublished Doctoral Dissertation, Syracuse University, Syracuse, New York, 1959.

88. Colville, Francis. "The Learning of Motor Skills as Influenced by Knowledge of Mechanical Principles." Unpublished Doctoral Dissertation, University of Southern California, Los Angeles, 1956.

89. LaPlante, Marilyn. "A Study of the Problem Solving Method of Teaching Bowling." Unpublished Master's thesis, The University of North Carolina at Greensboro, 1965.

90. Mikesell, Deloris J. "The Effect of Mechanical Principle Centered Instruction on the Acquisition of Badminton Skills." Unpublished Master's thesis, University of Illinois, Urbana, 1962.

91. Smith, Marilyn E. "A Study of Two Methods of Teaching Bowling to College Women." Unpublished Master's thesis, The University of North Carolina at Greensboro, 1966.

92. Zeigler, Yvonne P. "A Comparison of Two Methods of Teaching Gymnastics." Unpublished Master's thesis, The University of Wisconsin, Madison, 1965.

93. Zuber, Richard. "The Effect of Instruction in the Laws of Motion on Learning Gymnastic Stunts." Unpublished Master's thesis, University of Illinois, Urbana, 1957.

APPENDICES

APPENDIX A

RATING SCALE

<u>EXCELLENT</u> (5 points)

1. Perfect balance.
2. Legs straight and fully extended; legs tightly tucked.
3. Complete amplitude of body; body completely tucked.
4. Stunt technically correct.
5. Extreme neatness in execution.
6. Total ease of movement into stunt.

<u>GOOD</u> (4 points)

1. Balanced position of body.
2. Legs straight; tucked.
3. Incomplete amplitude of body--slight degree.
4. Neatness in execution.
5. Less ease of movement into stunt than above.
6. Controlled movements of body.

<u>FAIR</u> (3 points)

1. Small extraneous movements of body to get balance or perform stunt.
2. Legs slightly bent, or not tucked tightly.
3. Decidedly insufficient amplitude of body.
4. Execution lacking continuity.
5. Lacking ease of movement into and during stunt.

<u>POOR</u> (2 points)

1. Decided movements of body in order to regain balance.
2. Stopping between parts of the stunt.
3. Total lack of amplitude.
4. Body position technically incorrect.
5. General execution below average.

<u>UNSATISFACTORY</u> (1 point)

1. No balance point.
2. Supplimentary support necessary to execute stunt.
3. Body position incorrect, but resemblance of stunt.
4. General execution abrupt, jerky.

<u>FAIL</u> (0 points)

1. Complete failure to execute stunt.

APPENDIX B

RATING

NAME OR NUMBER		TEST	RETEST	TIME
	FORWARD ROLL			
	DIVE ROLL			
	BACKWARD ROLL			
	TRIPOD			
	HEADSTAND			
	CARTWHEEL			
	STRADDLE ROLL			
	PIKE BACKWARD ROLL			
	DRAG-UP HEADSTAND			
	HANDSTAND			
	ROUND-OFF			
	HANDSTAND FORWARD ROLL			
	HEADSPRING			
	BACK ROLL TO HEADSTAND			
	SHOOT THROUGH			

APPENDIX C

LESSON I

FORWARD ROLL

1. Place hands on mat shoulder-width apart.
   (The larger the base of support the more stable the body.)

2. Knees are bent and pointed out. Hips must be kept high.
   (Whenever one body part moves away from the line of gravity in one direction, the center of gravity shifts in that direction. If this shift puts the center of gravity beyond the base of support, another body part must move in the opposite direction to bring the center of gravity back over the base or balance will be lost.)

3. Tuck the head placing the nose between the knees and bend the arms gradually.
   (The longer the radius, the less the rotary velocity and the shorter the radius the higher the rotary velocity.)
   (Whenever one body part moves away from the center of gravity in one direction . . .)

4. Lean forward pushing against the floor with the feet and hands. The back of the neck should be the first body part to hit the mat.
   (A body at rest tends to stay at rest; a body in motion tends to remain in motion, unless acted upon by an outside force.)
   (The momentum from any body part can be transferred to the rest of the body.)
   (If a force is applied through the center of gravity linear motion will result; if the force is applied away from the center of gravity the object will rotate.)

5. Grab the knees on the way over to keep a tight tuck position.
   (The shorter the radius the higher the rotary velocity.)

6. As the feet hit the mat the body is extended and a standing position is assumed.
   (The longer the radius the less the rotary velocity.)

BACKWARD ROLL

1. Squat down placing the hands in front of the feet.
2. Sit back keeping the legs bent and head tucked.
   (The shorter the radius the higher the rotary velocity.)
3. Push against the mat with the hands.
   (To every action there is an equal and opposite reaction.)
   (If a force is applied through the center of gravity linear motion will result; if the force is applied away from the center of gravity the object will rotate.)
4. As the roll begins place hands above the shoulders, palms backwards, fingers pointing toward the shoulders.
5. Push against the mat with the hands.
   (To every action there is an equal and opposite reaction.)
6. Keep legs tucked as feet hit then push with legs and hands to assume a standing position.
   (The longer the radius the less the rotary velocity.)

DIVE FORWARD ROLL

1. Jump off two feet strongly extending the legs and leaning slightly forward.
   (To every action there is an equal and opposite reaction.)
   (Inverse--A body is balanced when its center of gravity is over the base of support.)
2. Hands reach forward and down as the weight is taken onto the slowly bending arms.
3. As the arms bend the head is tucked and the weight is taken off the hands and onto the back of the neck.
   (The head is not tucked until the arms hit. If the head

is tucked early the body will begin rolling too soon and the back will hit the mat before the neck.)

(If a force is applied through the center of gravity linear motion will result; if the force is applied away from the center of gravity the object will rotate.)

4. Finish as is in forward roll above.

LESSON II.

TRIPOD

1. Place the forehead on the mat with the hands shoulder width apart and near the body forming a triangle with the head.

   (The lower the center of gravity the more stable the body.)

   (The larger the base of support the more stable the body.)

2. Point the fingers forward and spread apart. Elbows are bent and the upper arm is parallel to the floor.

   (The wider the base of support the more stable the body.)

3. Bend the knees leaving the feet on the floor. Place one knee on each elbow keeping the weight balanced between the head and hands.

   (A body is balanced when its center of gravity is over its base of support.)

HEADSTAND

1. Form a tripod as explained above.

2. Tip the body forward shifting the hips slightly over the head and slowly raise the legs keeping them over the center of gravity as they move upward.

3. As the legs straighten the hips shift back and the back is slightly arched as the body balances.

   (Whenever one body part moves away from the line of gravity in one direction, the center of gravity shifts in that direction. If this shift puts the center of gravity beyond the base, another body part must move in the opposite direction to bring the center of gravity back over the base or balance will be lost.)

CARTWHEEL (to the left)

1. Stand with the left side of the body in the line of direction.

2. Step on the left foot kicking with the right foot and at the same time placing the left hand on the mat. The body is rotating around and ever changing point of contact with the floor and around its own center of gravity.

   (The momentum from any body part can be transferred to the rest of the body.)

3. Throw right leg up at the same time placing the right hand on the mat. At this point a momentary handstand is achieved with the arms and legs spread widely apart.

4. Bring the right foot to the mat as the left hand leaves.

5. Drop the left foot keeping it separated from the right foot.

6. Come to a stand. In this stunt the hands are placed on an imaginary line.

LESSON III

STRADDLE FORWARD ROLLS

1. Start standing with legs in a straddle position.

2. Bend forward piking at the hips.

3. Tuck the head tightly as the weight shifts and is taken onto the hands and neck.

   (The momentum from any body part can be transferred to the rest of the body.)

4. As the legs approach the ground place the hands between the legs on the mat with the fingers forward and arms straight.

5. Push forcibly against the ground with the hands and feet.

   (To every action there is an equal and opposite reaction.)

6. Tuck the head to prepare for next roll.

   (If a force is applied through the center of gravity linear motion will result; if the force is applied away from the center of gravity the object will rotate.)

   (The longer the radius the less the rotary velocity and the shorter the radius the higher the rotary velocity.)

PIKE OR STRADDLE BACKWARD ROLL

1. From a stand lean back onto the heels, sit back keeping the legs straight as the upper body is brought forward. Pike at the hips.

   (inverse--A body is balanced when its center of gravity is over the base of support.)

2. Just before the body hits the mat place the hands between the legs. The hands become the new point of support and the center of rotation.

3. Straighten the body and keep the body weight well forward. This relieves the force of the fall by producing rolling action because straightening of the body throws the center of gravity outside the base (seat).

4. As the feet hit keep them in the straddle position and stand by pushing with the hands.

   (If a force is applied through the center of gravity linear motion will result; if the force is applied away from the center of gravity the object will rotate.)

LESSON IV

HANDSTAND WITH SUPPORT

1. Stand with the arms toward the ceiling. This position will help develop rotary momentum which inverts the body.

2. Place both hands close to the feet, fingers spread, and forcibly kick up. Push with one bent leg against the ground and swing the other leg into the air.

   (The momentum from any body part can be transferred to the rest of the body.)

   (To every action there is an equal and opposite reaction.)

3. Keep the head up as movement of the head checks rotary action of the body.

4. Shoulders must be kept over the hands, body stretched upward, arms and legs straight, and back slightly arched.

   (The shoulder position keeps the gravitational line straight. The back arch helps keep a high center of gravity.)

DRAG-UP HEADSTAND

1. Start with the forehead on the mat, hands under the shoulders, body flat on the mat.

   (The larger the base of support the more stable the body.)

2. Keeping the body straight pike at the hips raising the hips upward and slightly toward the head.

3. Drag the straight legs until the feet are close to the hands on the mat and the hips are high.

4. Shift the weight forward toward the head raising the legs off the mat to the vertical position.

5. Quickly shift the weight back onto the hands and arch the back bringing the hips back over the head.

(Whenever one body part moves away from the line of gravity in one direction the center of gravity shifts in that direction. If this shift puts the center of gravity beyond the base, another body part must move in the opposite direction to bring the center of gravity back over the base or balance will be lost.)

LESSON V

ROUND-OFF (to the left)

1. Start as if doing a cartwheel, but cross the right arm slightly in front of the left. This helps turn the body.

2. As the handstand position is reached the legs are snapped together and a half twist is initiated at the hips.

3. The hips are flexed forcibly throwing both legs toward the mat.

   (The momentum from one body part can be transferred to the rest of the body.)

4. The feet land close to where the hands were placed as a strong push with the hands and arms are given.

   (To every action there is an equal and opposite reaction.)

5. The landing is in the opposite direction than the starting position.

HANDSTAND TO FORWARD ROLL

1. Balance in a handstand position as stated previously.

2. Overbalance slightly forward bending the arms slowly, tucking the head, and landing on the back of the neck.

   (Whenever one body part moves away from the line of gravity in one direction the center of gravity shifts in that direction. If this shift puts the center of gravity beyond the base, another body part must move in the opposite direction to bring the center of gravity back over the base or balance will be lost.)

3. Bend the knees and end in a forward roll coming to a stand.

   (The longer the radius, the less the rotary velocity; the shorter the radius the higher the rotary velocity.)

APPENDIX D

NAME ______________________________ SECTION ____

HOUR ____

EXPERIENCE (Days, Months, or Years) ______________

WHERE (High School, Y, Club, etc.) ______________________

TUMBLING STUNTS DONE WITH FAIR DEGREE OF ACCOMPLISHMENT:

____

____

____

APPARATUS WORKED ON: ________________________________

____

____

STUNTS PERFORMED ON APPARATUS WITH FAIR DEGREE OF ACCOMPLISHMENT:

____

____

____

APPENDIX E

MEAN RAW SCORES OF STUDENTS IN THE EXPERIMENTAL GROUP ON THE PRE-TEST AND POST-TEST OF EACH OF THE TWELVE STUNTS AND POST-TEST SCORES FOR THE THREE STUNTS USED IN THE POST-TEST ONLY

SUBJECT	FORWARD ROLL		DIVE FORWARD ROLL		BACKWARD ROLL	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1	2.7	3	0	2.7	2	3.3
2	1.3	2.7	0	2	1	2.7
3	2.7	3.7	2.7	1.7	1.3	2
4	2.7	3.7	3.3	2.7	1.3	2
5	1	4	0	3	0	2.7
6	3	3	2.3	3.3	1.7	3
7	2.3	3	0	2.3	1.3	2.3
8	2.7	3	0	2.3	1.3	2.3
9	3.3	4	1.3	4	2.3	3.7
10	3	3.7	0	2.7	2	3.3
11	0	2.3	0	2.3	0	2.3
12	2.7	3.3	0	2	0	2.3
13	3.3	3.7	4	3.7	3.3	3
14	3.3	3.3	3	3	2.3	3
15	2.3	3.7	2	3.7	0	2
16	3.3	3	0	3	1.7	2.3
17	3.7	3.7	2.7	3.3	2.3	4.3
18	1.7	3	0	2.3	0	1.7
19	3.7	4.3	0	3.7	2.7	4

EXPERIMENTAL GROUP (continued)

SUBJECT	TRIPOD		HEADSTAND		CARTWHEEL		STRADDLE FORWARD ROLL	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
1	3	4.7	2.7	4.7	2	2.7	0	1.7
2	0	3.7	0	2.7	1.3	3.7	0	2.7
3	0	3.7	0	2.3	2	1.7	0	2
4	4.7	5	3.7	2	0	1.3	0	2.3
5	0	4	2.3	3	2	3	0	.7
6	4	5	3	3.7	3	3.3	0	1.3
7	3.7	5	.7	3.7	2.3	4	0	1
8	3.7	4.7	2.7	3.3	1.7	2.3	0	2.7
9	4	4.7	4.3	4.3	3	3.3	0	3.7
10	3.3	4	2	2.7	1.7	2.3	.7	1.3
11	0	4.3	0	3	0	.7	0	2
12	4	5	3.3	3.3	3.3	3.3	0	2
13	4.7	5	4.3	3.7	0	0	0	2.3
14	4.3	4.7	3.3	3.7	2.7	3.3	0	3.7
15	0	4	0	0	1	2.7	0	1.3
16	3.3	4.7	0	2.7	2.3	2.3	1.3	2
17	1.3	5	2.3	4.3	3.3	3	0	3.3
18	0	2.7	0	2	2.3	3	0	2.3
19	4.3	5	3	4	3.7	4.7	2.3	3.3

	STRADDLE BACKWARD ROLL		DRAG-UP HEADSTAND		HANDSTAND		ROUND-OFF	
1	0	3	0	.3	1.3	3	0	3.7
2	0	3	0	.3	0	2.3	0	1
3	0	4	0	0	0	1.3	0	1
4	0	3	0	2.7	1.3	2.3	0	.7
5	0	0	0	0	1.7	3	0	3.3
6	0	2.3	0	3.7	2	2.7	0	2.3
7	0	1	0	1.7	2.3	2.3	0	2.7
8	0	1.7	0	1.7	.7	1.7	0	.7
9	0	3.3	0	3.7	2.3	3	0	2.7
10	0	2	0	1.3	0	2.7	0	2.3
11	0	3.7	0	.3	0	.7	0	0
12	0	1.7	.7	1.7	1.3	2	0	1.7
13	0	2.3	2	4	0	2.3	0	0

EXPERIMENTAL GROUP (continued)

SUB-JECT	STRADDLE BACKWARD ROLL		DRAG-UP HEADSTAND		HANDSTAND		ROUND-OFF	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
14	0	4.3	0	3.3	.3	3.3	0	3
15	0	0	0	0	0	0	0	0
16	0	2.3	0	0	0	1.7	0	2.7
17	0	3.7	0	2.3	2	2.7	0	2.3
18	0	2.7	0	0	0	2	0	1.3
19	0	4	.7	4	2.3	3.7	2.3	4

	HANDSTAND TO FORWARD ROLL		HEADSPRING	SHOOT-THROUGH	BACKWARD ROLL TO A HEADSTAND
1	0	3	.3	1.7	.7
2	0	0	1.7	2.3	0
3	0	0	1.3	2.3	.3
4	0	2.3	1.3	2.3	1.3
5	0	2.7	.7	.3	.3
6	0	3.3	1.7	2.3	1
7	0	2.3	.3	1.7	.3
8	0	2	.3	2.7	.3
9	0	4.3	.3	2.7	0
10	0	0	2	2.3	.3
11	0	0	.3	.3	1.3
12	0	.3	.3	1.7	0
13	0	2.3	2.7	2.7	1
14	0	3	2.7	2.7	.7
15	0	0	0	1	0
16	0	0	.3	2.3	0
17	0	2.3	3	2.3	1.7
18	0	1.7	0	1	0
19	0	3.3	3.3	3.3	.7

MEAN RAW SCORES OF STUDENTS IN THE CONTROL GROUP ON THE PRE-TEST AND POST-TEST OF EACH OF THE TWELVE STUNTS AND THE POST-TEST SCORES FOR THE THREE EXTRA STUNTS

SUBJECT	FORWARD ROLL		DIVE FORWARD ROLL		BACKWARD ROLL	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1	2	3.7	0	3.7	1.7	2.7
2	3.3	3.7	2	3.3	0	1.7
3	3.3	3.3	.7	2.7	3.7	3.3
4	3	3.3	0	4	1.7	2.7
5	2.3	2.7	0	2.7	0	2.3
6	2.3	2.7	0	2.3	1.3	2
7	3	3.7	0	3.3	1.7	3
8	2	3.3	0	3	2	2.7
9	1.7	2	0	0	1.7	2.3
10	4	3.7	1.7	4.3	2	3
11	3	3.7	1	3.7	2.7	3.7
12	2	3.3	0	3.7	2	2.3
13	3	3.7	0	4	3	3.7
14	3	3.3	0	2.7	1.7	3.7
15	1	3.3	0	4	1	3.7
16	0	3	0	1.7	0	1.3
17	1.7	2	0	3	1.7	2.7
18	2.3	3.3	1	3.3	2	3
19	1.7	2.7	.7	2	2	3.3
20	2	2.3	0	2.7	1.7	4
	TRIPOD		HEADSTAND		CARTWHEEL	
1	4.7	5	3	4.7	2.7	3.7
2	0	5	0	3.3	0	2.7
3	5	5	4	4.3	3.3	3.3
4	3	5	3	3.7	3	4
5	0	4	0	3	2	3.3

CONTROL GROUP (continued)

SUBJECT	TRIPOD		HEADSTAND		CARTWHEEL	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
6	0	4.7	0	2.3	0	0
7	2.3	5	2.7	3.7	2	2.3
8	3.7	5	4.7	3	0	0
9	0	2.7	0	0	2	2.3
10	4	4.3	1.7	3	1.7	3
11	4.3	5	0	4.7	0	0
12	.7	4	3.7	4.3	1.7	2.7
13	4.3	5	3.3	5	3	3.3
14	4	4.3	2.7	3	2.7	3.7
15	2.7	4.7	0	2.3	0	1.3
16	0	4	0	2.3	0	0
17	0	4	0	3	2	3
18	4	4.7	1	2.7	1.7	2.3
19	0	4.7	0	3	0	1.3
20	5	5	4.7	4.3	2.3	3.7

	STRADDLE FORWARD ROLL		STRADDLE BACKWARD ROLL		DRAG-UP HEADSTAND	
1	0	2	0	4	0	3
2	0	1.7	0	1.7	0	0
3	0	2.7	0	3.7	4.3	4
4	0	3.3	0	3	2	3
5	0	3	0	2.7	0	2.7
6	0	1.7	0	3.7	0	0
7	0	2	0	1.3	0	2.7
8	0	2.7	0	0	0	0
9	0	1.3	0	1.3	0	0
10	0	1.7	0	3.3	0	0
11	0	2.7	0	2.3	0	4.7
12	0	1.3	0	2	0	0
13	0	2	0	4	0	2
14	0	3	0	3	0	1.3
15	0	1.3	0	3.7	0	1.3
16	0	0	0	0	0	0
17	0	2.3	0	3.7	0	2.3
18	0	2.3	0	3	0	.7
19	0	1.7	0	2.7	0	.3
20	0	3	0	2.7	2.3	4.3

CONTROL GROUP (continued)

SUBJECT	HANDSTAND		ROUND-OFF		HANDSTAND FORWARD ROLL	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
1	2.7	4	0	0	0	4
2	0	2	0	0	0	0
3	0	2.7	0	3	0	2
4	1.3	2.7	0	0	0	0
5	0	2.3	0	0	0	0
6	0	0	0	0	0	0
7	1.7	1.7	0	0	0	0
8	0	1.3	0	0	0	1.7
9	0	1.3	0	1.7	0	1
10	1	3	0	.7	0	0
11	1	2.3	0	0	0	3
12	1	3.3	0	3.7	0	3.3
13	0	1.3	0	1.7	0	0
14	1.7	3.3	0	1.7	0	1.3
15	0	3.3	0	0	0	0
16	0	0	0	0	0	0
17	0	2.7	0	2	0	3.3
18	0	2.3	0	1	0	3
19	0	0	0	0	0	0
20	4	3	0	4	3	3.3

	HEADSPRING	SHOOT-THROUGH	BACKWARD ROLL TO HEADSTAND
1	1.7	4.7	1.3
2	.3	2	0
3	.7	2	1.7
4	1.3	2.	1
5	1	2.7	0
6	0	3.3	0
7	1.3	2.3	0
8	.7	0	0
9	0	0	0
10	.7	3	.7
11	2.3	0	.7

CONTROL GROUP (continued)

SUBJECT	HEADSPRING		SHOOT-THROUGH		BACKWARD ROLL TO HEADSTAND	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
12		.3		0		.7
13		1.7		1.3		1
14		0		1.3		.3
15		2		1.3		1.3
16		.3		2.3		0
17		1.7		2.3		.7
18		.3		1.3		.3
19		0		1		0
20		2.7		1.3		2.3

APPENDIX F

GENERAL MOTOR ABILITY SCORES

SUBJECT	EXPERIMENTAL GROUP	SUBJECT	CONTROL GROUP
1	65	1	64
2	48	2	50
3	61	3	66
4	53	4	55
5	51	5	54
6	58	6	50
7	53	7	53
8	54	8	55
9	66	9	54
10	50	10	51
11	42	11	59
12	51	12	46
13	71	13	55
14	68	14	59
15	51	15	56
16	63	16	68
17	69	17	53
18	55	18	54
19	61	19	58
		20	68