THE EFFECT OF A UNIT OF MOVEMENT EDUCATION UPON THE LEVEL OF ACHIEVEMENT IN THE SPECIALIZED SKILL OF BOWLING

A DISSERTATION

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We hereby recommend that the dissertation prepared under our supervision by Dorothy Morrow Coleman entitled "The Effect of a Unit of Movement Education Upon the Level of Achievement in the Specialized Skill of Bowling"

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Emerson's words have never before been so meaningful until this writer was confronted with the gracious guidance, assistance and encouragement during the process of this study--

> Nor knowest thou what argument
> Thy life to thy neighbor's creed has lent.
> All are needed by each one;
> Nothing is fair or good alone.

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table | Page

CHAPTER I

ORIENTATION TO THE STUDY

Movement

Brief History

The basic premise of movement education in the United States is not a new one. The importance of physical laws to effective and efficient movement was suggested by Watts[1] as early as 1914. Laban[2] presented the idea in 1920 that movement is basic to human existence; and although he valued dance for its contribution to artistic growth, individual worth, and scientific and educational benefits, he thought that the greatest value of dance was its ability to bring about discovery of self. Two early writers were Cureton[3] and Karpovich,[4] who published articles in the 1930's which dealt

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[1]Diana Watts, The Renaissance of Greek Ideals (New York: Fredrick A. Stokes Co., 1914).

[2]Rudolf Laban, Die Welt des Tänzers (Stuttgart: Verlag Walter Seiffert, 1920).

[3]Thomas K. Cureton, "Mechanics and Kinesiology of Swimming," Research Quarterly, Vol. I, No. 4 (December, 1930), pp. 87-121.

[4]Peter V. Karpovich, "Water Resistance in Swimming," Research Quarterly, Vol. IV, No. 3 (October, 1933), pp. 21-28.

with the application of physical laws to various activities. The first American textbook which applied the principles of physical laws to the teaching of physical education was written by Glassow[1] in 1932. It was not until the 1950's, however, that any appreciable interest was shown in movement education by professional physical educators. It was unfortunate that movement education was introduced to the profession at this time as "basic mechanics" or "body mechanics." Because of this extremely narrow interpretation given to movement education, there was little enthusiasm and acceptance of it and, in fact, much dissatisfaction resulted. The concept, as it was presented, did not encompass the entire gamut of physical education. However, there were professional individuals who saw real value in the basic premise of movement education; individuals who could see beyond the narrow concept of body mechanics. It was through the efforts of these few individuals that the 1956 Workshop of the National Association for Physical Education of College Women was devoted to examining the problems which had resulted from the narrow interpretation of movement education. It was hoped that the terminology and definitions of terms agreed upon by those present at the Workshop would, with general acceptance, do much to clarify or diminish the confusion and disagreement concerning

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[1]Ruth B. Glassow, Fundamentals of Physical Education (Philadelphia: Lea and Febiger, 1932).

movement education.[1] At the very least, professional physical educators could speak the same language.

The National Association for Physical Education of College Women maintains that movement is the tool employed by physical educators who seek to develop their students' potential; this tool may be used in a variety of ways; and, it is applicable to all facets of physical education.

In 1961 the National Section on Dance, more recently restructured as the Dance Division of the American Association for Health, Physical Education and Recreation, made a unified effort to establish new views and approaches to understanding movement. Described below are the six basic theories of movement, which have developed over the past 125 years, that were examined by this group in an attempt to reach a unanimous acceptance of a general concept.[2]

1. Francois Delsarte based his system of movement upon the law of trinity, which is comparable to our concept of time, force and space. His classifications of principles were: opposition, parallelism, and succession of sequence.

2. Emil Jacques Dalcrose developed the theory of Eurythmicy--a system of developing rhythmic potential through

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[1]National Association for Physical Education of College Women, "Definitions of Movement Terms," NAPECW Report (1964), p. 145.

[2]National Section on Dance, "Report: Theories of Movement," Focus On Dance II (Washington, D. C.: American Association for Health, Physical Education and Recreation, 1962).

the use of the body which, he believed, serves as the interpreter of musical rhythm.

3. Rudolph Laban analyzed and investigated the meaning of movement as it related to art, education, industry, recreation, and therapy.

4. Martha Graham's main theory--"contraction and release"--emphasizes the center of the body as the origin of movement.

5. The Humphrey-Weidman theory deals with creative exploration of movement values with emphasis upon body reactions.

6. Eleanor Metheny and Lois Ellfeldt postulate the theory that man makes sense out of what he sees, hears, touches, tastes, smells, and feels by forming concepts concerning these various forms of sensory data, and then transforming these concepts into symbolic forms by moving their bodies.

It is regrettable that the National Section on Dance was unable to reach a unanimous acceptance of a general concept of movement since this group is so intimately involved in movement.

It appears, at least to this author, that the lack of general acceptance of the concepts of movement education is due, not to a disagreement concerning the importance of movement to the ultimate or total development of the individual, but, to a problem of semantics concerning the various components which comprise movement education.

Basic Beliefs

In the past thirty-seven years, it has become increasingly apparent that the mind and body can not be separated if the individual is to develop to his fullest capacities. To cling to the Middle Ages' dualistic concept of the individual is totally unrealistic and completely false in the face of all the scientific evidence which points to the complexity of the interdependency of the body and mind. The fact that the body is physical and possesses mass, and this mass occupies space, proves to be confusing to some individuals when they are asked to consider it other than purely physical. A very obvious truth overlooked in such a belief is the fact that the human body is capable of producing energy and, thus, is able to move itself.[1] If the human body were strictly physical this would not be possible; it could be moved only by an external force.

Slusher indicates that "mind and body can not be separated nor can one be placed above the other in importance."[2] In the case of the human body, one can not exist without the other nor can one develop without the other.

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[1]Eugene F. Kaelin, "Being in the Body," NAPECW Report (1964), p. 90.

[2]Howard S. Slusher, "The Existential Function of Physical Education," NAPECW Report (1964), p. 133.

Some individuals consider the physical aspects of a person less significant than the intellectual aspects. The results of such limited considerations can only assure that the learning process will be less effective than it could have been. According to the most recent and most widely accepted theory concerning human learning, the physical aspects of an individual constitute the process through which learning takes place and the intellectual aspects represent the extent, or the results, of the process.[1,2] Physical anthropologists indicate that throughout the evolutionary process it appears that man's increasing capacity for movement and the growing complexity of the nervous system were mutually interdependent functions, each contributing to the development of the other.[3]

The conclusions of studies conducted by psychologists prior to the 1930's relate that human performance and learning are based upon reaction to discrete sensory stimuli and that learning depends upon the strengthening of the bonds between stimuli and the responses of the organism.[4] Since the 1930's,

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[1]Kaelin, op. cit., p. 99.

[2]Delbert Oberteuffer and Celeste Ulrich, Physical Education (New York: Harper and Row, 1962), p. 61.

[3]Julian Huxley, A. C. Hardy, and E. B. Ford, Evolution as a Process (London: Jarrold and Sons Limited, 1958), pp. 197-198.

[4]Ernest R. Hilgard, Theories of Learning (New York: Appleton-Century-Crofts, Inc., 1948), pp. 15-45, 48-79, 82-119, 121-182, 185-220.

psychology theorists have maintained that stimuli within the environment are organized into patterns and that the resulting performance is based upon the meaning attached to the total field of experience.[1]

Research findings indicate that a two-factor theory of motor performance can be supported.[2,3,4,5] The two-factor theory contends that there are several groups of general abilities which are essential or fundamental to performance. These abilities are largely independent of each other, but they contribute to the execution of several groups of skills.[6] These general abilities include: (1) Efficient utilization of space in accurate movement, (2) The ability to summon and to exert maximum force and speed when needed, (3) Freedom from excess tension, (4) Motivation, and (5) The ability to

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[1]Ibid., pp. 222-255, 258-288, 307-325, 328-366.

[2]Patricia Woodward, "An Experimental Study of Transfer of Training in Motor Learning," Journal of Applied Psychology, Vol. XXVII (1943), pp. 12-32.

[3]Paul M, Fitts, "The Information Capacity of the Human Motor System in Controlling Amplitude of Movement," Journal of Experimental Psychology, Vol. XLVII (1954), pp. 381-391.

[4]Bryant J. Cratty, "Comparison of Learning a Fine Motor Task with Learning a Similar Gross Motor Task Using Kinesthetic Cues," Research Quarterly, Vol. XXXIII, No. 2 (May, 1962), pp. 121-221.

[5]Bryant J. Cratty, "Transfer of Small-Pattern Practice to Large-Pattern Learning," Research Quarterly, Vol. XXXIII, No. 4 (December, 1962), pp. 523-535.

[6]Bryant J. Cratty, Movement Behavior and Motor Learning (Philadelphia: Lea and Febiger, 1964), pp. 50-51.

analyze a complex task.[1] Cratty indicates that, in addition to these general abilities, individuals have numerous specific abilities which are primarily the result of ones' opportunity to manipulate and explore within his environment.

Metheny[2] suggests that much of life and what life means can not be neatly presented in sentence form. This fact in no way limits the importance of these feelings about life because they play an important role in the behavior of each individual, even though they can not be verbalized or stated completely in words and sentences. It is true that individuals behave according to what they think or according to meanings derived from sensory experiences--it appears to be so, according to knowledge concerning the learning process--movement behavior is a mental behavior, just as any other behavior is mental. An individual learns to move in the same way he learns to read, by structuring perceptions into integrated wholes that are meaningful as symbolic forms.[3] Movement is created out of the forces which act upon man, the results of interactions between the internal forces and

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[1]<u>Ibid</u>.

[2]Eleanor Metheny, "An Inquiry Into the Nature of Movement as a Significant Form," <u>Connotations of Movement in Sports and Dance</u> (Dubuque: Wm. C. Brown Co., 1965), pp. 17-18.

[3]<u>Ibid</u>., pp. 76-77.

external forces--"Too much like thinking to be less than thought."[1]

Regarding the superiority of the conditioned response over the simple reflex action, Kaelin suggests that "it is reasonable to admit that excitation, conditioning and/or inhibition do not completely explain all that exists in the learning behavior of human beings."[2] He goes on to say that "existence of the body is a process of meanings which progress toward the whole, a whole which is interpreted as how much and how good."[3] The purpose of developing motor skill is to be able to accomplish desires or to meet needs in the most efficient way without consciously having to think through each movement before or during each task performance. The possession of motor skills aid in the enrichment of living.

The development of a cultural environment is a product of the body having transformed its meanings into symbols. Kaelin expresses this point rather artistically with his translation from Merleau-Ponty:

> Vision and movement are specific manners of relating ourselves to objects; and if, by all these experiences, a unique function is expressed, it is the unfolding of an existence which does not supress the radical diversity of its contents. For, it relates whatever contents it has not by placing them under the strict control of an "I think," but by orienting them towards the intersensorial unity of a "world."[4]

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[1]Ibid., p. 19.

[2]Kaelin, op. cit., p. 93.

[3]Ibid.

[4]Ibid., p. 103.

Much of the present research concerning movement is being conducted in industry, psychology, anthropology, various aspects of the medical profession, the performing arts, and numerous fields of education. The widespread interest in this kind of research is an indication that efficient movement is important to our present society and also an indication that there is still much to be learned about efficient, effective movement.

It would appear, according to current beliefs, that the purpose of education is to continuously strive for more refined, highly developed, and specialized behavioral patterns of human conduct. This can not be done by pretending that the beginning stages or foundations do not exist or by considering them less significant than the higher patterns of behavior, or by denying that the higher patterns have no relationship to the lower. This concept might be compared to a building--there would be no second floor without a foundation and a first floor, and, how high the building can be built will depend upon the characteristics or properties of the foundation. How practical, durable, and useful the building will be depends entirely upon the thought, planning, and foresight of the individual responsible for its construction. The same premise holds true in education. How fully developed an individual becomes depends upon educators' ability to see all of the necessary components involved in this developmental process. The cultural needs of a society change from time to time as that society moves through the process of civilization. Education must not only prepare individuals to cope with the future but, more important, to be able to fashion it in a manner which not only meets human needs but challenges the best capacities of man--not the best capacities of a few individuals, but the best capacities of all individuals.[1,2,3]

Movement Education

A close look at current physical education programs reveals that those activities which are most closely related to the body are the very ones which have either been ignored or given a minimum amount of attention.[4] The activities which would make possible the exploration of movement are noticeably absent in too many programs of physical education. Too often the body has been regarded only as a means to attain an end and then only as it relates to a specific activity. There has been a tendency to coach for perfection of skill development, and in many cases this has resulted in

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[1]Education Policies Commission, The Central Purpose of American Education (Washington, D. C.: National Education Association, 1962).

[2]Education Policies Commission, Social Responsibility in a Free Society (Washington, D. C.: National Education Association, 1963).

[3]President's Commission on National Goals, Goals for Americans (Washington, D. C.: The American Assembly, 1960).

[4]Seymour Kleinman, "The Significance of Human Movement: A Phenomenological Approach," NAPECW Report (1964), p. 126.

an extremely limited repertoire of movement patterns for the student. Movement becomes significant to an individual through a knowledge about the body and through an awareness of self, which develops through moving the body. Slusher suggests that:

> Every question of human existence may be answered in movement. However, the degree to which this will be attained will be dependent upon the degree to which the individual attains awareness.[1]

The major areas of concern in movement education are:

1. Development of physical qualities necessary to effective movement.

2. Development of an awareness of the principles which are involved in human movement.

3. Development of an understanding of how these principles affect movement.

4. Development of basic movements.

5. Application of mechanical principles and combining basic movements to develop fundamental motor patterns which may be modified as needed in order to develop specialized skills which relate specifically to a particular activity.

The basic premise of movement education, as stated by Broer, is:

> Movement is used in some way to some degree, in every task accomplished by human beings. The need of every individual is to understand human movement so that any task, light or heavy, fine or gross, fast or slow, long or short duration, whether it

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[1]Slusher, op. cit.

> involves everyday living, work, or recreational skills can be approached effectively.[1]

The challenge to physical educators is to assist individuals in learning to use their bodies effectively in the performance of all tasks demanded of it. Broer[2] maintains that physical educators who understand the basic mechanical principles and their application to human motion can teach knowledges important to all skills through any specific activity. This concept moves beyond the practice of developing a few isolated, specialized skills. In movement education there is less concern with how the student looks and more concern with the mechanical efficiency, energy expenditure, and rhythmic quality of the movement.[3] Basic movement education should include numerous opportunities for body movement in relation to a great variety of objects. Hopefully, children who are exposed to this kind of education will have a large repertoire of movement patterns and an understanding of principles involved in movement by the time they reach high school.

Cardinal to the theory of movement education is the premise that the physical laws of motion which govern all movement also govern human movement. This theory also implies that the specialized skills which make up all the various

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[1]Marion R. Broer, Efficiency of Human Movement (2nd ed.; Philadelphia: W. B. Saunders and Co., 1966), p. 3.

[2]Ibid., p. 328.

[3]Ibid., p. 332.

physical activities involve the use of the same fundamental movements and motor patterns, modified according to the specific purpose of the particular activity.[1] Therefore, if the physical principles of movement are learned and understood, applications can and/or should develop, which would facilitate all motor skill learning.

Theory of Transfer Relevant to Movement Education

Advocates of movement education and psychologists do not use the terms "motor skill performance" and "motor learning" synonymously. Motor skill performance is specific, according to what is known at the present time about the establishment of pathways within the nervous system. However, motor learning is both general and specific.[2] In addition to the actual task specifics, there are a number of general conditions that contribute to motor performance.

Even though Thorndike[3,4] believed very strongly in the theory of identical elements, he recognized the existence of general principles. To use his words:

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[1]Ibid., p. 338.

[2]N. L. Munn, "Bilateral Transfer of Learning," Journal of Experimental Psychology, Vol. XV (1932), pp. 343-353.

[3]E. L. Thorndike and R. S. Woodworth, "The Influence of Improvement in One Mental Function Upon the Efficiency of Other Mental Functions," Psychological Review, Vol. XIII (1901), pp. 247-261, 384-395.

[4]E. L. Thorndike, Educational Psychology (New York: Teachers College, Columbia University, 1924), p. 269.

> Every change must be in a specified bond, and though, as a rule, these bonds are between concrete, particular responses, some of these particularized bonds are of very widespread value. There are bonds involving situations and elements of situations which are, in the ordinary sense of the word, general.[1]

Judd, the first individual to propose the theory of generalization, believed very strongly "that some general ability to analyze the task factor underlies performance."[2,3] He also suggested that the nature of the task and the ability of the learner to understand and to apply basic performance principles seems to determine the extent of their effect upon learning efficiency.

Skinner[4] declared that learning simple skills consists of reorganizing into an action pattern movements already learned. Movements are organized into skills; therefore, readjustments of previously automatized patterns are necessary.

Trow[5] contends that there is confirmed evidence to support the desirability of learning by grouping discrete

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[1]E. L. Thorndike, Educational Psychology, Vol. II (New York: Teachers College, Columbia University, 1921), p. 418.

[2]C. H. Judd, "Movement and Consciousness," Psychology Review, Vol. VII (1905), pp. 199-226.

[3]C. H. Judd, "Special Training and General Intelligence," Educational Review, Vol. XXXVI (1908), pp. 28-42.

[4]B. F. Skinner, The Behavior of Organisms (New York: Appleton-Century-Crofts, Inc., 1938), p. 437.

[5]William Clark Trow, Educational Psychology (Dallas: Houghton Mifflin Co., 1950), pp. 520-521.

items into meaningful wholes, preferably relating them to some principle. In each new learning situation, however, there are retained patterns from previous experience ready to go into action. It is necessary, therefore, for the learner to perceive and identify the familiar components in the new situation and then select the correct response.

From this investigator's review of numerous studies and publications, she concluded that leading authorities agree that transfer of learning does have a definite affect upon subsequent learning. She further agrees with Cratty "that transfer is dependent upon a combination of factors both general and specific,"[1] rather than being a simple, one to one, relationship between factors. The process of transfer of learning is a complex, complicated, interdependent functioning of all the various factors; and, continued study and research is necessary before it can be fully understood.

Statement of the Problem

This study involved ninety-three students enrolled in the required program of physical education at the Texas Woman's University in Denton, Texas, during the first and second semesters of the academic year of 1966-1967, in an attempt to investigate the contributions and the importance of movement education as a prerequisite to instruction in a

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[1]Cratty, Movement Behavior and Motor Learning, p. 271.

selected physical education activity. Specifically, the problem was to investigate the effectiveness of a prerequisite unit of movement education upon the level of achievement in the specialized skill of bowling.

Purpose of the Study

The general purpose of this inquiry was to test the following hypothesis: The result of participation in a prerequisite unit of movement education will effect a higher level of achievement in the specialized skill of bowling than will specialized skill instruction without the unit of movement education.

The specific sub-hypotheses to be tested were:

1. The Thorndike theory of "identical elements" and the Judd theory of "generalization" are not opposing theories in their meanings for educational practices.

2. Students beginning the bowling unit one week after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education unit and/or the students beginning the bowling unit one month after the completion of the movement education unit.

3. Students beginning the bowling unit one month after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling

unit than will the students who do not receive the movement education unit.

4. Students beginning the bowling unit one week after the completion of the movement education unit will achieve a higher final bowling score than will the students who do not receive the movement education unit and/or the students beginning the bowling unit one month after the completion of the movement education unit.

5. Students beginning the bowling unit one month after the completion of the movement education unit will achieve higher final bowling scores than will the students who do not receive the movement education unit.

6. The application of mechanical principles to the specialized skill of bowling will affect bowling scores favorably.

Definitions and Explanations of Terms

The following definitions and/or explanations of terms were accepted for use as they relate to this study.

1. Movement Education: Providing experiences through which an individual develops understanding of, appreciation for, and skill in human movement.[1]

2. Basic Movement: Unstructured movement carried on for its own sake and for increased understanding and awareness of the movement possibilities available to the

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[1]National Association for Physical Education of College Women, op. cit.

human body.[1]

3. Body Mechanics: Physical laws applied to the human body at rest or in motion.[2]

4. Fundamental Motor Patterns: Patterns that form the foundation for the specialized skills required in daily life, work, sports, and dance.[3]

5. Specialized Skill: Motor patterns which are refined, modified, and/or combined to accomplish specific purposes.[4]

6. Learning Curves: A graphic representation of the successive scores (or group means) of an individual as he learns a task.

In general, motor learning curves are characterized by an initial stage of relatively rapid improvement followed by a phase in which improvement is not so rapid.[5]

7. Plateau: A period during which little if any improvement takes place.[6]

8. Initial Mean Score: The average of the scores of the first three lines bowled (games 1-2-3).

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[1] Ibid.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Hilgard, op. cit., p. 370.

[6] Ibid., p. 373.

9. Mid-point Mean Score: The average of the scores of the three lines bowled midway in the bowling unit (games 9-10-11).

10. Final Mean Score: The average of the scores of the last three lines bowled (games 18-19-20).

11. Formal Instruction in Bowling: A formal class situation with a student-instructor relationship in which a particular unit of instruction is covered.

Limitations of the Study

The present study was subject to the following limitations:

1. Ninety-three students enrolled in the required program of physical education at the Texas Woman's University in Denton, Texas, during the first and second semesters of the academic year of 1966-67.

2. A movement education unit of instruction related specifically to bowling, encompassing ten hours of class time.

3. A teacher-constructed test to determine the students' knowledge of mechanical principles of movement.

4. A unit of bowling instruction to continue until the required twenty lines of bowling had been recorded.

5. A rating scale to determine the application of mechanical principles to the specialized skills necessary in bowling.

6. Scores obtained from each student on twenty lines of bowling.

Survey of Related Literature

Psychological literature is replete with studies on the learning process and transfer of learning; whereas, physical education literature is somewhat limited by comparison in reporting studies based upon psychological information in applied situations. After a thorough review of the literature in both fields, the investigator concluded that her study did not duplicate any previous study reported.

The following digests of reported research are offered as examples of the many studies in the literature which provided background information and guidelines for the development of this study.

An article appearing in the Psychological Review in 1901[1] was the first of a number of articles reporting facts as indicated by Thorndike and Woodworth. The chief method of investigation was to test the efficiency of some function or functions, then to give training in some other function or functions until a certain amount of improvement was reached, and then to test the first function or set of functions.

The experiments were concerned with the influence of the training on efficiency and on ability as measured by a single test, not on the ability to improve. The authors suggested that it is possible that improvement in one function might fail to give improved ability in another, however,

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[1]Thorndike and Woodworth, *op. cit.*

it may make possible faster improvement than would have occurred without the training. Evidence in the investigators' experiments indicated the probability of the following conclusions:

1. It is misleading to speak of sense discrimination, attention, memory, observation, accuracy, quickness, and the like, as multitudinous separate individual functions.
2. It is misleading to speak of these functions as exercised without narrow fields.
3. The mind is a machine for making particular reactions to particular situations. It works in great detail, adapting itself to the special data it has experienced.
4. Improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar, because the working of every mental function group is conditioned by the nature of the data in each particular case.
5. No change in data is without effect on the function and there is always a point where the loss in efficiency of a function trained with certain data is complete.
6. In cases of retention or loss of practice effect makes it seem likely that spread of practice occurs only where identical elements are concerned in the influencing and influenced function.[1]

Samples of the influence of training in one function on the efficiency of other functions reported by Thorndike and Woodworth included: (1) Influence of special training in the estimation of magnitudes on the ability to estimate magnitudes of the same general sort; partial formation of a number of associations, (2) The influence of training in observing words containing combinations of letters, and

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[1] _Ibid._, pp. 249-250.

(3) The influence of special training in memorizing on the general ability to memorize.

In each of the experiments, the authors described and then tested the influence of improvement in a specific function on other functions closely allied to it. Wissler's and Norsworthy's studies were cited as being of particular interest.

The conclusions as stated by the authors were:

> In four cases out of six examined it is impossible to attribute the differences to chance. The probability that the differences in all the series are due to chance is small. The differences are, therefore, not chance, but significant; the ability to judge one magnitude is sometimes demonstrated better than the ability to judge another, one function is better developed than its neighbor. The functions of judging nearly equal magnitudes are, sometimes, at least, largely separate and independent. A high degree of ability in one sometimes co-exists with a low degree of ability in others.[1]

Judd,[2] in his investigation in 1908, indicated that those who have advocated the doctrine of specific functions have had a very limited view of the facts involved. According to the results of his experiments, he concluded that transfer of practice is a complex process which must be studied from a variety of points of view.

The types of transfer suggested by the investigator are: (1) Joint improvement, (2) Reciprocal interference, (3) After initial training, a decreased capacity for acquiring new adjustments.

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[1] Ibid., pp. 260-261.

[2] Judd, Educational Review, pp. 28-42.

Judd contended that there were facts to justify the statement that mental functions are interrelated and interdependent in the most encompassing ways. He further asserted that every experience changes the individual's capacity for new experiences. The author mentions a study started by Scholckow which was never finished and explains how he carried this experiment a little further. Judd's study involved two groups of fifth and sixth grade boys who were required to hit a small underwater target with a small dart. The difficulty in hitting the target was that of refraction, which light experiences through reflection.

In this study, one group of boys was given a full theoretical explanation of refraction. The other group was left to practice without the theoretical explanation. The target was placed under twelve inches of water in the first test. In the first series of trials, the theoretical explanation seemed to be of no value since all of the boys had to learn to use the dart. Theory proved to be no substitute for practice.

The conditions were changed; and, the target was placed under four inches of water. At this point the differences between the two groups were striking. The boys without the theory were very confused and they repeatedly made the same errors. The boys who had been exposed to the theory rapidly adapted to the changed conditions.

The author pointed out that the theory was not of value until it was backed by practice; but, when practice and theory were both present, the best adjustment was worked out rapidly. Theory was not proposed as a substitute for practice. It was suggested as an additional method, supplementary to practice.

The investigator admitted that the experiment was not carried far enough to determine how long the boys without theoretical training would have to work at the problem in order to overcome their confusion. It was noted that this group did master the four inches, but again was confused with eight inches.

Judd maintained that every experience has in it the possibilities of generalization. Whether or not this generalization is worked out depends upon the individual's abilities and interest. He emphasized the point that there is nothing in such an experience which would lead one to speak of training as specific and incapable of generalization.

Judd was emphatic about his belief that a dogmatic answer to transfer of training is totally impossible.

Bruce,[1] in 1933, conducted a study concerning the conditions of transfer of training. This author indicated that all transfer studies may be classified on the basis of

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[1]Robert W. Bruce, "Conditions of Transfer of Training," Journal of Experimental Psychology, Vol. XVI (1933), pp. 343-361.

whether a differentiation is made between the stimulus and response terms of the experimental study and the extent to which these terms are subjected to variation.

This study was an investigation of some of the conditions of transfer of training concerning:

1. Relation of conditions of learning to transfer:
   A. New response to old stimulus.
   B. Old response to new stimulus.
   C. New response to new stimulus.
2. Relation of the degree of integration of initial learning to transfer:
   A. New response to old stimulus.
   B. Old response to new stimulus.
3. Relation of certain similarities between $S_1R_1S_2R_2$ terms of the initial and subsequent learning material to transfer:
   A. New response to old stimulus.
   B. Old response to new stimulus.

The learning material used was nonsense syllables. Eighty-one college students served as subjects. Nine subjects were used in each condition; and, each student was tested individually.

The investigator concluded that: (1) Learning to make an old response to a new stimulus results in a marked degree of positive transfer, (2) Learning to make a new response to a new stimulus results in a slight degree of positive transfer, (3) Learning to make a new response to an old stimulus results in a slight degree of negative transfer, (4) Introducing similarities between two or more of the $S_1R_1S_2R_2$ terms increases positive transfer and decreases negative transfer, and (5) By increasing degrees of integration of the initial learning there is an increase in the amount of positive transfer and a decrease in the amount of negative transfer. Where the amount of negative transfer is light, it shifts to positive transfer.

Hendrickson and Schroeder,[1] in 1941, conducted a study which was an attempt to check on an earlier studied, started by Scholckow and later finished by Judd, in which the investigators reported that knowledge of the principle of refraction proved to be beneficial in dart throwing at an underwater target. The intent was to attack the same problem in a similar fashion, but with no claim of duplication since there was no complete record of the previous research design. The authors maintained that only a vague description of the procedures and the conclusions of the investigation were available.

Ninety eighth grade boys served as subjects in this study. These subjects were divided into three groups of thirty: experimental group A, experimental group B, and a

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[1]Gordon Hendrickson and William H. Schroeder, "Transfer of Training in Learning to Hit a Submerged Target," Journal of Educational Psychology, Vol. XXXII (1941), pp. 205-213.

control group. The mean age and the mean percentile rank of intelligence were used in an attempt to equate the three groups. Markmanship was not tested for all three groups. Two of the groups had been compared in a preliminary experiment and the result indicated that there were no negligible differences between the boys matched in age and intelligence.

Air guns were used in this study, rather than darts, as in the original study. The experimenters recorded each hit as it was made. Accuracy of the hit was determined on the basis of visual observations.

Two problems were set up for the control group: (1) To hit a designated target with the water depth at six inches, and (2) To hit a designated target with the water depth at two inches. Three consecutive, successful hits were required for the first problem before the subjects were allowed to progress to the second problem.

Conditions and requirements were the same for the two experimental groups as for the control group. The subjects in the two groups were given a written explanation of the theory of refraction and were permitted to study until they declared that they knew the principle. The subjects were not allowed to ask questions. Experimental group B was given one more sentence of explanation than group A received.

The two experimental groups received additional time, as well as additional information, which certainly could have influenced the results of the study. The following results were reported:

1. Problem One:

   Both experimental groups learned more rapidly than the control group; and, group B learned more rapidly than group A. The differences were not high but were statistically reliable.

2. Problem Two;

   The degree to which the instructed subjects surpassed the uninstructed group appears to have depended upon the explicitness of the theoretical explanation.

The investigators acknowledged the fact that motivation of the subjects might have had a considerable effect upon the results of the study in that the subjects participated with strong enthusiasm, which resulted in very strong competition.

The authors concluded that the degree of motor skill necessary for this study was negligible. The real problem was discovering how and where to aim. The results indicated that there were large individual differences in the speed of success within each of the three groups. Knowledge of the theory proved to facilitate transfer. Theoretical information was of aid not only in transfer from one situation to the other, but also in making the original adjustment to the situation.

The purpose of the Woodward[1] study in 1943 was to determine whether a significant degree of transfer in motor learning occurs when the training consists of learning a task which is identical with the "test" task in the pattern of motions involved, but, requires the manipulation of entirely different materials. The test task was the assembly of a loom safety switch; the sequence of motions was the same as the safety switch but entirely different in material, shape, and appearance.

One hundred and seven girls from two vocational high schools were used as subjects. They were divided into groups of five for the original and final tests, each test period lasting forty-five minutes. In the initial test, six looms were assembled; in the final test, twelve looms were assembled.

The control group did only the two tests. The experimental group returned for periods of forty-five minutes, five days a week, for fifty-seven times. This group was taught and then practiced the assembly of the safety switch. The only instructions given were those for the assemblies.

The findings of the study revealed that transfer of learning did occur; and, the author suggested the following reasons for the occurrence of the transfer: (1) Similarity of the two assemblies, (2) Near identity of specific motions,

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[1]Woodward, op. cit.

(3) General patterns of motion, (4) Total work situation, and (5) A combination of all.

In Colville's[1] investigation in 1957, an attempt was made to investigate certain questions related to teaching physical activities in which specific principles of mechanics were involved.

Three principles of mechanics pertinent to motor skills and three motor skills which utilized these principles were selected for use in this study. Two equated groups were established for each of the skills; one group was taught with no reference to the principle involved, while the other group spent part of the time practicing the skill as well as learning the principle. The total amount of time was the same for each group. The groups were compared according to skill performance in a more complicated form of the skill to which the same principle applied.

The principles selected were:

1. The angle of incidence is approximately equal to the angle of reflection.
2. In stopping a moving object, the force opposing the momentum must be equal to the force of the momentum; if the object is to be caught, this momentum must be dissipated by reducing the resistance of the catching surface.
3. An object set in motion through the air by an external force is acted upon by the force of the momentum and by gravital acceleration.[2]

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[1]Frances Colville, "The Learning of Motor Skills as Influenced by a Knowledge of General Principles of Mechanics," Journal of Educational Psychology, Vol. XLVIII, No. 6 (October, 1957), pp. 321-327.

[2]Ibid., pp. 323-325.

The skills selected were:

1. Rolling a ball against a surface from which it would rebound.
2. Catching a tennis ball in a lacrosse stick and catching a badminton bird on a tennis racket.
3. Archery.[1]

Undergraduate college women were used as subjects: thirty-six in the ball rolling experiment; forty in the catching experiment; and, forty-two in the archery experiment (some men were included in this group).

The investigator concluded that the utilization of mechanical principles in the performance of motor skills did not facilitate the initial learning of a skill any more than did an equal amount of time spent in practicing the skill. However, such knowledge did facilitate the subsequent learning of a similar or more complicated skill to which the same principles applied.

In 1958, Broer,[2] investigated the effectiveness of a general basic skills curriculum for junior high school girls. The author recognized that general motor ability, developmental level, and intelligence would have some influence upon the study.

The investigation consisted of seventeen periods of instruction which included volleyball, softball, and basketfall. The experimental group, in addition to the instruction

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[1]Ibid.

[2]Marion R. Broer, "Effectiveness of a General Basic Skills Curriculum for Junior High School Girls," Research Quarterly, Vol. XXIX (December, 1958), pp. 379-388.

in basic skills of movement, received only one-third as much specific instruction in volleyball as the control group, only two-thirds as much specific instruction in basketball, and the same amount of specific instruction in softball. The investigator used three previously established classes. One class served as the control group and the other two classes served as the experimental group.

The results were measured in terms of improvement which was determined according to achievement in eight sport skill tests. The results of the study indicated that the experimental group scored higher on all of the sport skill tests than did the control group.

The purpose of Cratty's[1] study reported in May of 1962 was to compare the performance and learning rates of a fine motor task and of a gross motor task, while holding constant the sensory cues and the maze pattern utilized.

The task consisted of learning to traverse two irregularly patterned mazes. The pathway of one was thirty times longer than that of the smaller stylus maze. The subjects were blindfolded and learned the patterns using tactual-kinesthetic cues.

The following terms were defined:

1. Gross Motor Task: A task which involves movement of the entire body through space, through large muscle activity. The body's center of gravity changes position through locomotion. It

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[1]Cratty, Research Quarterly, No. 2.

may be accompanied by fine adjustments of the head and/or the extremities.
2. Fine Motor Task: A task that involves movements of the body's segments through space, while the body's center of gravity remains fixed. A fine motor task may involve arm and leg movements, exclusive of, or accompanied by hand-finger manipulation. The larger muscles of the body generally act as stabilizers during the performance of such a task.[1]

Sixty male university students, divided into two groups of thirty, were given twelve blindfolded trials to learn each of the mazes. They were requsted to move as rapidly as they could through the irregular patterns which constitute no blind alleys. They were not informed of their traversal times, nor did they see either maze until the completion of the study. They were asked to use the palms of their hands while moving through the large maze.

Thirty subjects received twelve trials in the large maze, three times a week (M-W-F) for four weeks. The other group of thirty learned the smaller maze under the same conditions. Following twelve trials on their initial tasks the groups exchanged problems and learned the second maze under the same conditions.

Traversal times were recorded to the nearest 1/10 second on both mazes. The subject's verbal comments and movement characteristics also were recorded. After learning each maze, the subjects were asked to report, using an inquiry form, the type of sensory impressions they depended

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[1] Ibid., p. 213.

upon while moving through the patterns--that is, vocal, tactual, motor, visual, or a combination of impressions. They were asked to draw the pattern of the maze they had just learned on the same inquiry form.

The results were:

1. The subjects held a more accurate conception of their traversal times than they did of the spatial conformations of the pathways.

2. The main sensory impressions the subjects depended upon when learning the large maze were: (a) Motor-tactual (fourteen subjects), (b) Visual-motor (twelve subjects). The visual-motor image was usually reported for learning the smaller maze (twenty-four subjects).

3. The subjects' traversal speeds, verbal comments, and their drawings of the pathways all illustrated that a primacy-recency factor was present in the learning of both mazes. The first portions of the pathways were learned first, then the last turns, and finally the middle portions of the patterns.

4. A contingency coefficient illustrated that little relationship existed between the sensory impressions an individual reported using on one maze and those he said he used to learn the other. Nineteen subjects, however, stated that they used the same sensory impression when learning both mazes.

5. Analyses of variances illustrated that neither the sensory impression reported, nor the subject's abilities to draw the pathways, facilitated or impeded their traversal speeds.

6. Correlation of performance levels of both tasks revealed that no significant relationship existed. The author indicated that the lack of a relationship between the performance levels of the two tasks was due to a spatial factor.

The findings seemed to substantiate the recently formulated neurogeometric theory which holds that human movements are similar only if they occupy identical spatial dimensions.

The learning curves indicated that some transfer had taken place between the two tasks. How much of this was due to similarity of the movement patterns involved was not known. There was frequent evidence that considerable unconscious (subcortical) learning had taken place.

The author concluded that the results of the investigation led him to believe that accurate spatial performance based upon kinesthetic cues is a specific ability.

Mohr and Barrett,[1] in 1962, reported the results of a study conducted to determine the effect of knowledge of

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[1]Dorothy R. Mohr and Mildred E. Barrett, "Effect of Knowledge of Mechanical Principles in Learning to Perform Intermediate Swimming Skills," Research Quarterly, Vol. XXXIII, No. 4 (December, 1962), pp. 574-580.

mechanical principles in learning to perform intermediate swimming skills.

Thirty-one students enrolled in two intermediate swimming classes served as subjects. Two groups were established: an experimental group and a control group. The experimental group, consisting of fifteen students, was exposed to an understanding and application of mechanical principles as they related to the front crawl, back crawl, side stroke, and elementary back stroke. The control group received identical instruction in the particular swimming strokes but were not given the material concerning mechanical principles.

The two groups were equated according to scores obtained on tests administered to measure initial speed and power. The same tests also were given at the end of the experiment. A rating scale was devised; and, three DGWS Nationally Rated Swimming Officials rated each of the subjects on each of the strokes. The sum of the scores of all three judges was used to determine the total score for each student. Objective tests were administered at the beginning and the end of the study.

This experimental study consisted of an initial three week testing period, eight weeks of instruction, and three weeks of final testing. Mimeographed information was given to both groups during each class session but only the experimental group received information concerning mechanical principles. Written tests were administered to both groups periodically covering the material to which the subjects were exposed.

The means and standard deviations for improvements were determined and the two groups were compared, using the *t*-test. The investigators concluded:

> The experimental group made significantly greater improvement than did the control group, during eight weeks of instruction, in all strokes but the elementary back stroke. Specifically, these improvements were in the front crawl sprint, the side stroke power test, and the form ratings for the front crawl, back crawl, and side strokes. These findings support the hypothesis that exposing students to an understanding and application of mechanical principles will effect greater improvement than instruction without reference to these principles.[1]

Cratty's[2] study, reported in December of 1962, was an attempt to determine whether transfer occurred between the learning of two similar spatial patterns, one thirty times larger than the other, and specifically to assess whether prior practice of various small spatial patterns would impede or facilitate the learning of a task involving larger movements.

Sixty male university students were randomly assigned to four groups of equal size. One group received twelve spaced trials (M-W-F) on a stylus maze containing a pattern similar to that of a large locomotor maze. The second group received practice, under the same conditions, on a stylus

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[1] *Ibid.*, p. 579.

[2] Cratty, *Research Quarterly*, No. 4.

maze containing a pattern which was a mirror reversal to that of the larger maze. The third group had twelve spaced trials on a stylus maze containing a pattern unrelated to that of the larger maze. The fourth group received no small-maze practice, only twelve spaced trials on the large maze.

The subjects learned all mazes while blindfolded and saw none until the study was completed. The subjects were urged to move as rapidly as they could through the irregular pathways. They were told that they would not be bothered during their traversals and that there were no blind alleys. After learning the small mazes, the three experimental groups received the same number of trials under the same conditions in a large locomotor maze, having a pathway thirty times longer, and ninety times wider.

The conclusions of the study were: (1) Prior reverse small-pattern practice of the larger one caused initial negative transfer to the larger pattern, (2) Prior similar small-pattern practice caused initial positive transfer to the larger pattern, and (3) The experimenter was led to consider the negative and positive transfer largely unconscious, due to the fact that the subjects did not report awareness of the pattern relationship involved, either during or at the completion of the study.

Cratty was unable to explain the transfer from different sizes of movement patterns and from movements involving different muscle groups and dissimilar time intervals required for performance. He suggested that the Gestalt theory is able to account for the transfer, in that the patterns are learned as wholes. The subjects attached holistic meanings to the patterns and did not rely upon the chaining together of discrete muscle stimuli. The stress placed upon speed of performance and the fluid nature of the pathways seemed to have resulted in a lack of conscious awareness of the pattern relationships involved.

The findings point to the existence of a temporal phenomenon associated with the transfer concept. The author suggested that specificity of motor skill would appear open to criticism according to the results of his study. The neurogeometric theory of human motion advocating specificity of functioning of postural movements, of limb movements, and of manipulative movements is particularly difficult to reconcile with the present findings. Cratty claimed that many specificity theories seem to ignore past experience as a molder of behavior, and such basic factors as ability to analyze a motor task and freedom from tension.

He further suggested that one might hypothesize the existence of a general factor involving the accurate utilization of space and eventually arrive at a two-factor theory of motor learning.

Summary

Through the investigation conducted by this author it is apparent that there is general agreement, among some of the authorities in various fields which contribute to the total spectrum of education, that transfer of learning does have a definite affect upon subsequent learning. It is apparent, also, that there is a glaring lack of, or use of, a universal vocabulary referring to learning and transfer of learning.

Throughout all of the materials reviewed and cited in this chapter, the common acceptance of the Gestalt theory of learning was inescapable. The Gestalt theory in teaching is a holistic approach. A theory that advocates the importance of insight learning. This theory holds that experience is always structured, that we react not to separate details, but to a complex organization or patterns of stimuli. Individuals attempt to perceive stimuli in organized wholes, not in disconnected parts.

It seems almost a universally accepted belief that an individual learns from previous task experience through understandings. Through understanding, the individual is able to transfer his experience to a wider range of situations.

The arrangement of the subject or task, materials of instruction, and the order in which they are presented will greatly enhance the students' observations, comprehension, and learning.

In Chapter I of this dissertation, the author has presented various concepts of several authorities from the fields of psychology, education, and physical education regarding: learning and transfer of learning, as each relates specifically to movement; and, movement education, in terms of basic beliefs and understandings. The statement of the problem, the purposes, the definitions and explanations of terms, and the limitations of the present study also were presented.

Numerous research reports related to the topic being investigated were examined; and, the writer presented a review of ten studies considered particularly applicable to the development of this research project.

Chapter II includes a detailed description of the procedures followed in the development of the study.

CHAPTER II

THE DEVELOPMENT OF THE STUDY

The present study was designed to investigate the effectiveness of a unit of movement education, taught as a prerequisite, upon the level of achievement in the specialized skill of bowling. Definite procedures were developed and adhered to in the conduct of this study. These procedures are presented in detail in this chapter under the following major headings: (1) Sources of Data, (2) Development of the Unit of Movement Education, (3) Development of the Bowling Unit of Instruction, (4) How the Movement Education Unit was Taught, (5) How the Bowling Unit was Taught, and (6) Treatment of Data.

Sources of Data

The data utilized in this study were gathered from both documentary and human sources. The documentary sources included the judges' rating sheets and the written test which were designed to ascertain the subjects' knowledge of and application of mechanical principles. The scores of twenty lines (or games) of bowling for each subject also served as documentary sources of data. The human sources of data included ninety-three women students enrolled in the required program of physical education at the Texas Woman's University in Denton, Texas, during the academic year 1966-1967. Other human sources included the investigator and the three individuals who served as judges during the bowling unit of instruction.

The Three Groups of Subjects

In order to determine the effectiveness of the unit of movement education upon the level of achievement in the specialized skill of bowling, it was necessary to limit the subjects for participation in the unit of movement education (Delayed Experimental Group and Experimental Group) to those college women who had had no previous formal instruction in bowling or who had never bowled more than four complete lines.

It was necessary, according to the research design of the study, that the subjects who participated only in the unit of bowling instruction (Control Group) be limited to those college women who had had no previous formal instruction in bowling or who had never bowled more than four complete lines. In addition, the subjects in this group were limited also to college women who had had no previous formal instruction in a unit of movement education. The word of the student concerning her previous experiences in formal instruction in a movement education unit and in a bowling unit of instruction was accepted at face value after a thorough explanation of the definition of these terms had been given to her. The students who served as subjects in each of the three groups were screened empirically by the investigator in order to eliminate subjects who had any apparent physical disabilities, or who had more knowledge of or experience in bowling than was desired for participation in this study.

In order that the purpose of this study might be accomplished, it was necessary to establish three groups of subjects: A Delayed Experimental Group, An Experimental Group, and A Control Group.

The Delayed Experimental Group (DE)

The Delayed Experimental Group consisted of thirty-three volunteer subjects enrolled in two body mechanics classes taught by the investigator during the first semester of 1966-67. Each student in this group met the criteria established for the selection of subjects in this study. One class met from 4:30 P.M. to 5:30 P.M., Monday, Wednesday, and Friday, and the other class met from 4:00 P.M. to 5:30 P.M., Tuesday and Thursday. It is important to emphasize the fact that students were allowed to select or reject the possibility of being a subject in this study even though they were enrolled in the particular classes which had been designated as available for use in this inquiry during the first semester. Another point needing emphasis is that not all of the students enrolled in these classes met the previously described criteria for selection and, thus, were not eligible to become subjects. In addition to the volunteers from these two classes, additional volunteers from other classes in the required program of physical education were included in this group and attended one of the two classes, described above, for instruction in movement education.

The movement education unit began January 3 and January 4 and continued for a period of ten hours of instruction, ending January 12 and January 16. The bowling instruction for the Delayed Experimental Group began March 7 (forty-eight days after the completion of the unit of movement education) and continued until each member of the group had completed the required twenty lines of bowling.

The Experimental Group (E)

Thirty volunteer subjects enrolled in a body mechanics class taught by the investigator during the second semester of 1966-67, comprised the Experimental Group. Each student in this group met the criteria established for the selection of subjects in this study.

The movement education unit for the Experimental Group began February 10 and continued for ten hours of instruction, ending on March 3. Upon completion of the movement education unit, this group moved immediately into the bowling unit of instruction on March 6. The bowling instruction was continued until each member of the group had completed the required twenty games of bowling.

The Control Group (C)

The Control Group consisted of thirty volunteer subjects enrolled in a bowling class taught by the investigator during the second semester of 1966-67. Each student in this group met the criteria for the selection of subjects in this study. The Control Group continued in the bowling instruction until each subject had completed the required twenty lines of bowling.

Judges' Ratings

The intended purpose of the judges' ratings was to evaluate each subject's ability to apply mechanical principles as they relate to the human movement necessary to the specialized skill of bowling.

Selection of Judges

Of the eight characteristics of the ability to successfully judge personality traits in others, related by Stagner,[1] four had direct application to the judging situation established as a portion of this investigation. The four characteristics directly applicable were: (1) Experience, (2) Similarity of the person being judged, (3) Intelligence, and (4) Detachment.

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[1]Ross Stagner, Psychology of Personality (New York: McGraw-Hill Book Co., Inc., 1936), pp. 276-277.

Taft[1] indicates that the main qualities of the ability to judge others seems to fall within three areas: possessing appropriate judgment norms, judging ability, and motivation.

Stroup[2] explains that persons making ratings must have a thorough knowledge of the traits to be judged, an adequate acquaintance with the individuals to be judged and a genuine interest in the rating.

According to Symonds[3] one method of increasing reliability of rating scales is to increase the number of judges. He found that the self-consistency of the average judge on a single personality trait is about .55. To raise the figure of .55 to .82 requires the use of four judges.

Stagner[4] points out that reliability of ratings varied with different traits. Objective traits can be rated more consistently than can more subjective traits or ambiguous qualities.

Since personality traits are more subjective in nature than the physical performance traits to be rated in this investigation, it was concluded that three judges would

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[1]Ronald Taft, "The Ability to Judge People," Psychological Bulletin, Vol. LII (1955), pp. 1-23.

[2]Francis Stroup, Measurement in Physical Education (New York: Ronald Press Co., 1957), p. 162.

[3]Percival M. Symonds, Diagnosing Personality and Conduct (New York: Appleton-Century Co., Inc., 1931), p. 95.

[4]Stagner, op. cit., p. 30.

provide the necessary reliability of the rating scale. The investigator was cognizant of the practical and physical aspects of the judging situation. Because of the number of subjects to be judged, the arrangement of class sessions and the period of time during the bowling unit at which the ratings would be of most value, the investigator further subscribed to the practicability of using three judges.

The three judges were selected according to the criteria suggested by the authorities previously quoted: (1) Thorough, even exceptional, knowledge of the traits to be judged, (2) Intelligence, (3) Detachment, (4) Judging ability, and (5) Genuine interest in the ratings.

Training of the Judges

Stagner states that "raters can develop more reliable and valid techniques through instruction and practice."[1] Guilford,[2] Barrow and McGee,[3] and Scott and French[4] also agree on this point. Guided by the opinions of these authorities the investigator planned a training period for the judges prior to the actual rating sessions.

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[1] Ibid., p. 33.

[2] J. P. Guilford, Psychometric Methods (New York: McGraw-Hill Book Co., Inc., 1936), pp. 276-277.

[3] Harold M. Barrow and Rosemary McGee, A Practical Approach to Measurement in Physical Education (Philadelphia: Lea and Febiger, 1964), p. 534.

[4] M. Gladys Scott and Esther French, Measurement and Evaluation in Physical Education (Dubuque: Wm. C. Brown Co., 1959), p. 39.

The first phase of this period consisted of a meeting of the judges with the investigator in which: (1) The purpose of the rating was explained and discussed, (2) The eight applications of the principles to be observed were explained and discussed, (3) The quantitative ratings were explained and discussed, (4) The minimum amount of time for observation of each subject was established, and (5) A time for a practice rating period was agreed upon. This first phase of training accomplished general agreement and understanding concerning each of the items discussed.

The second phase of training consisted of a practice rating session in which eight women bowlers in one of the city bowling leagues were rated, using the prepared rating scale. After completing the ratings the judges discussed their ratings and were able to establish some anchor points.[1] A rank order correlation was run in order to determine the agreement between the three judges.[2] The results were Judges X and Y, .77; Judges X and Z, .89; and Judges Y and Z, .73. The judges were considered to be in agreement since all correlation coefficients were between the .05 and the .01 per cent level of significance.

Rating Scale

According to Barrow and McGee, "observation techniques are used when no objective measurement exists for a

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[1]Barrow and McGee, op. cit., p. 534.

[2]Scott and French, op. cit., p. 83.

quality, or when it appears expedient to supplement objective measurement by subjective opinion."[1] Both of these purposes were to be served through the use of the rating scale as it was designed for this study.

Stagner lists five errors commonly made when employing the use of rating scales or subjectively judging individuals; errors of: (1) Definition, (2) Distribution, (3) Unequal units, (4) Halo effect, and (5) Stereotypes.[2] He points out that such errors would not only reduce reliability but also the validity of a rating.

The investigator made every effort to avoid the errors which are common when rating scales are used by:

1. Employing a training period with judges through which explanations were given and understandings were reached concerning:

   A. Terms used on the rating scale.

   B. Application of particular principles to be rated.

   C. The range of points and/or satisfactory categories.

2. Carefully selecting the judges--each was an experienced bowler and an experienced teacher of bowling. Each had demonstrated comprehension of the mechanical principles necessary in the specialized skill of bowling. Each

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[1]Barrow and McGee, op. cit., p. 524.

[2]Stagner, op. cit., pp. 30-32.

had considerable experience in judging performance in bowling. All three of the judges had, on numerous occasions, been exposed to a variety of skill abilities in the specialized skill of bowling.

3. Making certain that the raters had no contact with the subjects to be judged except during the designated judging periods. The subjects were designated by numbers rather than by name; and, there was no verbal exchange between the subjects and the judges. The judging periods were arranged to provide the maximum amount of objectivity.

The investigator found it necessary to construct the rating scale to be used in the judges' ratings since there was no existing instrument which would meet the specific needs of this particular research design. The primary considerations in the construction of the rating scale were to:

1. Keep the rating scale simple.[1]

2. Determine and define applications to be observed.[2]

3. Determine and select categories which would adequately define the levels of abilities.[3]

4. Design the rating scale in such a manner that

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[1]Scott and French, op. cit., p. 40.

[2]Ibid., p. 39.

[3]Barrow and McGee, op. cit., p. 528.

the evidence available would represent the true ability of the beginning bowlers.[1,2]

5. Construct the rating scale which would facilitate accuracy and ease of scoring.[3]

According to Ghiselli and Brown[4] there is no generalization concerning discrete categories as to the number of steps or standards to be employed when constructing rating scales. Either reliability or ease of rating may be used as a basis for the optimal number of steps.[5] It appears to be a rather general consensus of opinion that the number of steps which yield the highest reliability will vary considerably with the nature of the traits being rated. Because there is no established number of steps or categories that should be used on rating scales, this investigator decided upon a middle position in relation to suggestions offered by various authorities.[6,7,8] The investigator also relied upon

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[1] Ibid., p. 40.

[2] Carter V. Good and Douglas E. Scates, Methods of Research (New York: Appleton-Century-Crofts, Inc., 1954), p. 682.

[3] Barrow and McGee, op. cit., pp. 530-531.

[4] Edward E. Ghiselli and Clarence B. Brown, Personal and Industrial Psychology (New York: McGraw-Hill Book Co., Inc., 1948), p. 107.

[5] Ibid.

[6] Ibid., pp. 107-108.

[7] Deobold B. Van Dalen and William J. Meyer, Understanding Educational Research (New York: McGraw-Hill Book Co., 1966), pp. 318-319.

[8] Scott and French, op. cit., pp. 406-407.

the opinions of the judges concerning this matter since they were all experienced bowling teachers and well acquainted with the abilities of bowlers at various skill levels.

The rating scale constructed for use in this investigation consisted of eight applications of mechanical principles to be rated. A brief definition of each principle was included below each major heading. Four categories were used to represent the abilities of each subject on each principle being applied. The numerical values ranged from a high of four to a low of one, these values were indicated to the side of the principle to be rated in such a manner that the judge had only to check the appropriate value. Each form was constructed in such a manner that a complete team could be rated on one page. The sum of the ratings of the three judges was used as the score for the bowling rating scale.[1] A score of ninety-six was possible for each subject. A copy of the bowling rating scale may be found in the Appendix.

Mechanics and Climate of the Rating Situation

The criteria established and adhered to for the control of the situation in which the ratings were conducted included:

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[1] *Ibid.*, p. 402.

1. Subjects were rated during class participation (no competition).[1]

2. Judges had no previous knowledge of subjects or of subject's performance.[2]

3. Each subject was observed a minimum of six attempts (six balls rolled). Judges could observe more than, but not less than, six attempts.[3]

4. Judges were placed in the best position for an unobstructed view of subjects.[4]

5. Judges had sufficient, even ample, time to execute their ratings.[5]

6. Judges were instructed to use all categories (4-3-2-1).[6]

7. Rating forms had the subject's identification number already recorded on them which corresponded to the number on the back of each subject.[7]

8. The judges worked independently of each other.[8]

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[1]Barrow and McGee, op. cit., pp. 533, 534.

[2]Ibid., p. 532.

[3]Scott and French, op. cit., p. 404.

[4]Barrow and McGee, op. cit., p. 534.

[5]Scott and French, op. cit.

[6]Ibid., p. 406.

[7]Ibid., p. 405.

[8]Ibid., p. 81.

Development of the Unit of Movement Education

A unit of movement education was developed in which students were exposed to an understanding and application of basic movements, body mechanics, and fundamental motor patterns. This unit was planned and conducted in such a manner as to bring about the learning of gross motor activity as it related to the specific skills necessary in bowling. The established criteria for the construction of the unit of movement education included knowledges concerning: (1) Transfer of learning, (2) Methods and techniques of teaching, (3) Body mechanics and fundamental motor patterns as they relate to the skills necessary in bowling, (4) Laws of learning, and (5) Motivation.

Because of the specific nature of this study and the time available in which to conduct the study, the movement education unit was limited in that the movement principles and fundamental motor patterns taught were only those which related specifically to the specialized skill of bowling. Bowling was not specifically mentioned in the unit of movement education but the fundamental knowledges and skills necessary to the development of the specialized skill of bowling were taught.

The movement education unit was taught by the investigator and was as nearly identical as humanly possible for the experimental groups DE and E with respect to the:

(1) Length of time for the presentation of the unit, (2) Materials presented, (3) Methods of instruction, and (4) Actual presentation.

Selection of Principles

The investigator has been interested and actively involved in developing materials and teaching in the area of movement education at the college level for the past seven years in an attempt to determine an effective course of movement education to be used as a prerequisite to all other physical activity instruction. Also the investigator has been actively involved for the past eleven years in developing a complete and effective unit of instruction in bowling at the college level. The investigator's past teaching experiences and interests coupled with her extensive reading in the areas of the psychologyof learning, motor learning, and movement education have supplemented and strengthened her preparation for the execution of this experimental study.

The investigator relied heavily upon the writings of Scott[1] and Broer[2] in the selection of the movement principles and motor patterns which were included in the unit of movement education utilized in this inquiry.

The movement principles taught were limited to those which had direct or indirect application to the specialized

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[1]M. Gladys Scott, Analysis of Human Motion (New York: Appleton-Century-Crofts, 1963).

[2]Broer, Efficiency of Human Movement, pp. 25-103.

skill of bowling. The movement principles selected for inclusion in the unit of movement education were:

1. Gravity--

   A constant force pulling all objects downward. Subjects were introduced to the ways in which gravity can affect human movement.

2. Center of Gravity--

   The center of a mass (or object). Subjects were exposed to the theory that the location of the center of gravity determines the ease with which an object may be balanced. This was done in relation to the human body, symmetrical objects, and irregular objects.

3. Balance--

   A state of poise, remaining position or stability, or equal distribution of weight. The fact that balance is an active process was brought out in this presentation. The various ways of increasing body balance were presented.

4. Motion--

   The process of moving, or changing place, or position. A situation in which the position of an object and its support is changing. In this presentation the factors which modify motion were determined. Newton's Laws of Motion were presented along with the various types of motion which are possible.

5. Friction--

Resistance between two surfaces where one is sliding or rolling on the other. The importance of friction to motion was presented as well as ways of increasing or decreasing friction and making use of existing friction.

6. Force--

Strength or power exerted upon an object; impetus or intensity of effect. Magnitude, direction of application, and point of application of force were major considerations. Force production within the human body and methods of absorbing force were also presented.

7. Centrifugal Force--

Tendency of an object in the process of rotation to go off on a tangent to the arc of rotation. The importance of this principle in the underhand throwing pattern was presented, as well as timing of release.

8. Parallelogram of Force--

The vertical and horizontal lines are in proportion to a force applied at an angle to an object. The resultant of the application of force. This principle was presented in terms of applying the force produced by the human body and the ways of determining the direction in which an object will move in addition to the effectiveness of the force application.

9. Momentum--

The product of mass (weight) times velocity (speed) of an object. Ways of producing, increasing, and transfer of momentum were presented.

10. Absorbing Force--
Deceleration or stopping a moving object. Reducing momentum. Reasons for and methods of absorbing force were presented along with the force of impact when force is absorbed.

11. Axes of Rotation--
Center around which parts turn. The two types of axes were discussed in terms of the human body and the ease and range of movement.

12. Levers--
A simple machine for execution of work, a rigid bar turning about an axis. The types of levers were presented in terms of the human body. The type of movement that results, ways to increase or decrease force production, the importance of resistance, and the importance of leverage to maximum force production in the human body were major considerations in this presentation.

13. Movement of Inertia in Angular Motion--
Effectiveness of resistance to angular motion. The major emphasis was in presenting the theory that the more concentrated the mass around the axis the less the amount of inertia and the greater the distance the force is applied from the axis the greater is the effect in producing rotation about the axis. This was done in relation to the arm swing.

14. Air Resistance--

Resistance of the air wall to an object passing through it. The major emphasis was in determining the effect of air resistance on various types of objects--both projectiles and rolling objects. Ways of increasing or reducing air resistance upon an object were presented.

15. Spin--

An object (in this case a ball) is turning around a vertical or horizontal axis through its center. The different types of spin were presented along with their effects upon a rolling object (ball).

16. Rebound--

An object which meets resistance is acted upon by a counter-force--rebound. The rebound of a striking object as well as the rebound of the object hit were discussed, in addition to the factors which modify speed and angle of rebound.

Selection of Motor Patterns

Only those motor patterns which had direct or indirect application to the specialized skill of bowling were taught. The motor patterns selected to be included in the unit of movement education were:

1. Standing--

All the aspects which contribute to a balanced standing posture were considered.

2. Balancing Weight on One Foot--
   Knowledges concerning center of gravity and use of counterbalancing forces.
3. Walking--
   The process of disturbing and regaining the balance of the body as it moves. Application of force, momentum of the body, and absorption of momentum were also a major concern in presenting this pattern of movement.
4. Holding and Carrying--
   The major emphasis in this area was centered primarily on the most efficient way of holding and carrying added weight in terms of maintaining a balanced body position and employing counterbalancing forces to effect this desirable balanced position while the body is moving.
5. Underhand Throwing Pattern--
   Transfer of momentum, ways of increasing force application and decreasing resistance to force, ways to increase the possibility of accuracy, the direction of the application of force, counterbalancing forces, increasing the duration of the application of force, application of centrifugal force, and the effect of the various types of spin upon a rolling ball were all included in the presentation of this motor pattern.

Movement Education Materials Developed by the Investigator

Written Unit for Students

After the investigator had selected the principles and the motor patterns which were to be included in the unit of movement education it became apparent that there was a considerable amount of material to be covered in just ten hours of instruction. The investigator determined that it would speed up learning, or at least facilitate the learning process, if the subjects had written material concerning each of the principles and motor patterns which they could learn and understand, or at least be exposed to, before the instruction, demonstrations, and opportunities for exploration were provided in class. The investigator developed written explanations of movement principles and motor patterns which were distributed to each subject. These materials were distributed periodically rather than all at one time due to the fact that the materials developed proved to be rather voluminous, at least in comparison to the materials usually presented in a regular class of required physical education. In an attempt to avoid an overwhelmed reaction on the part of the subjects to the volume of material to be covered, the investigator distributed four movement principles and three motor patterns at one time. The materials were given to the subjects well in advance of the time it was to be explained, discussed, demonstrated, and explored in class.

The subjects were instructed to read and learn the material and to make note of questions they wanted or needed to ask when the material was actually presented during class. Copies of these materials may be found in the Appendix of this manuscript.

The Teaching Unit

The teaching unit for the movement education instruction was prepared solely for use by the investigator. This material was developed for the purpose of organizing and scrutinizing the factual information in order to determine the best approach to teaching the essential materials within a minimum period of time. As an additional teaching device, short tests were prepared covering the major aspects of each principle and given to the subjects after each presentation of four principles. The primary purpose of this periodic testing was to emphasize the major points which had been covered in the presentation of the principles.

Written Test

A comprehensive written test was constructed for the purpose of determining the subjects' intellectual ability to apply their knowledge of movement principles and fundamental motor patterns to practical situations. The investigator's concern in the construction of this instrument was to test the application of the knowledges which were actually taught, not the subjects' knowledge of technical terms or facts that might be memorized.

Every effort was made to utilize common terminology in the construction of this written test. Technical terms or terminology associated specifically with movement education were kept to an absolute minimum since this test also was administered to the Control Group in the study, which had not been exposed to a formal unit of instruction in movement education.

This written test was administered to the subjects in the Delayed Experimental and Experimental Groups upon the completion of the movement education unit and again at the completion of the bowling unit of instruction. The subjects in the Control Group took the test prior to their participation in the bowling unit and again at the completion of the unit of bowling instruction.

The results of the written test were not made known to the subjects and the test was not discussed with the subjects in any way. After the first administration of the test, the investigator was aware that this was not the best approach with respect to the motivation of the subjects, but the investigator was concerned at this time with protecting the reliability of the test. It may well be that the precautions taken with the written test were unnecessary and were the result of false concern. A copy of the written test is included in the Appendix.

Development of the Unit of Bowling Instruction

The bowling unit of instruction included exposure to an understanding and application of basic movements necessary in bowling; physical laws of motion--those related to human movement (body mechanics) and those related to the objects involved in bowling (mechanical principles); fundamental motor patterns which are necessary in bowling; and a brief explanation of the history, rules, terminology, and score keeping. The investigator believed that each of these aspects could contribute to the end product which was the development of the specialized skill of bowling.

The established criteria for the development of the unit of bowling instruction included knowledges related to: (1) Transfer of learning, (2) Methods and techniques of teaching, (3) Body mechanics and fundamental motor patterns as they affected the specialized skill of bowling, (4) Laws of learning, and (5) Motivation.

The bowling unit of instruction was taught by the investigator and was as nearly identical as humanly possible for all three groups with respect to: (1) Length of time for the presentation of the unit, (2) Materials presented, (3) Methods of instruction, and (5) Actual presentation.

Every effort was made by the investigator to avoid spending time on anything that was not essential to skill development. The bowling unit of instruction concentrated on knowledges, fundamentals, and applications which would facilitate the process of learning the necessary skills required for successful bowling. In an attempt to facilitate learning, the following procedures were adhered to: (1) Only four bowlers were assigned to a lane, (2) Individual instruction and assistance was provided after the initial period of group instruction, (3) A minimum of rules were presented, and (4) Individual tally sheets and graphs of learning curves were available for student reference.

Bowling Materials Developed by the Investigator

Written Unit for Students

Due to the limited amount of time in which the unit of bowling instruction could be presented, the investigator concluded that it would facilitate learning if the subjects had written material available for reference, which they could read, learn, and understand before the actual class instruction. For this reason the investigator developed a written bowling unit for the subjects which included:

1. A brief history of bowling.
2. An explanation of the game of bowling.
3. A brief explanation and example of score keeping.
4. A short summary of rules and etiquette.
5. Definitions of the most frequently used bowling terms.
6. Information concerning the fundamentals of bowling:

A. Selecting bowling equipment.

B. The types of approaches:

1) Three step approach.

2) Analysis of the four step approach.

3) Five step approach.

C. Types of deliveries:

1) Curve.

2) Back-up.

3) Straight.

4) Hook (natural)

D. Aiming:

1) Theories of aiming:

(a) Spot.

(b) Pin.

(c) Line.

2) Spare pick-up.

E. Release of the bowling ball.

7. An explanation of the major mechanical principles involved in bowling which included:

A. Force.

B. Balance.

C. Direction control.

D. Rebound or counterforce.

This material was distributed to each subject as a complete unit. Various parts of the unit were assigned in advance of the time it was actually covered in class instruction. Following the same pattern used with the unit of movement education, the subjects were instructed to read and learn the material assigned and to make note of questions they wanted or needed to ask during the actual class presentation.

The Teaching Unit

As in the movement education teaching unit, the teaching unit for the bowling instruction was prepared only for use by the investigator. This material was organized and presented according to: (1) Knowledges gained through eleven years of teaching bowling to college students in the required program of physical education, and (2) In such a manner as to determine the best approach to teaching the specific skills necessary to bowling within a minimum period of time. The areas of major consideration in the teaching unit included:

1. Explanation and drill in the stance and four step approach, including the principles of movement involved:
   A. Leg movements.
   B. Arm movements.
   C. Coordination of leg and arm movements.
2. The natural hook delivery.
3. Arm swing in terms of movement in a vertical plane, emphasizing the importance of the continuation of the arc of movement (follow-through).
4. Moment of release.

5. Aiming or point of aim in:
   A. Spot bowling:
      1) Strike pocket.
      2) Spare pick-up.
   B. Line bowling--for diagonal spare pick-up.
6. Methods for improving accuracy.
7. Fundamentals involved in and instruction in the various types of spare pick-ups.
8. Score keeping.
9. Check points for the thinking bowler.

Score Sheets

The regular bowling score sheet was used for the recording of each game bowled by every subject. Originally the investigator had planned to supply score keepers for each team in each of the three groups involved in the study. It soon became apparent that the possibility of securing this many score keepers for twenty games of bowling would be next to impossible; therefore, the investigator decided it would be more practical to take the time to teach the subjects to keep score for themselves.

After six hours of bowling instruction, the students were assigned material to read concerning score keeping. During the next class session each subject was given programmed material on score keeping and was asked to complete the material outside of class and bring it to the next class meeting. At the following class session, score keeping was demonstrated and explained with the use of the telescore--a machine which throws the score sheet upon an overhead screen. After a thorough explanation of score keeping and when all questions had been answered, the subjects began to keep score. The investigator checked all score sheets after each class in order to determine the types of mistakes being made. The old score sheets with the mistakes corrected were returned to the teams in order for the subjects to see where they had made mistakes and, hopefully, to correct them.

After twelve hours of instruction, the next game bowled was recorded by the investigator as the first of the subjects' twenty games required in the research design.

Individual Tally Sheets

An individual tally sheet was designed by the investigator for the purpose of recording the score of each game bowled and the current average for each subject. The score for each game was recorded only after the investigator had checked the addition of the score according to the way it was marked on the score sheet.

The purpose for the individual tally sheet was to have an accurate, systematic record of speed of learning, degree of learning, improvement in bowling, and success in bowling for each subject.

Individual Graphs

A graphic record of individual bowling scores was charted for each subject. The purpose of charting the individual scores was to have a graphic picture of speed of learning, the degree of learning, improvement and success in bowling. Originally this was done primarily for the investigator's benefit; but it proved to be of great interes to the subjects. As a matter of fact, it turned out to be a strong motivating factor. The graphs were distributed to the subjects at the beginning of each class period and were returned to the investigator after the subject had an opportunity to see how she was doing.

Graph of Group Progress

A graphic record of the progress of each of the three groups (DE, E, and C) indicating speed of learning, degree of learning, and success in bowling was kept. Recording was done at game intervals (initial, mid-point and final) rather than after each game.

Written Test

The written test, described under the heading Development of the Unit of Movement Education, was administered upon the completion of the bowling unit of instruction. The procedures for its administration were fully stated in that section of the chapter. The purpose of administering the written test a second time was to determine whether subjects gained in their intellectual ability to apply movement principles to practical situations.

Rating Scale

A rating scale was constructed by the investigator for the purpose of determining the application of movement principles to the fundamental skills necessary in the specialized skill of bowling. The rating scale included the specific skills of:

1. Push away on the first step.
2. Forward incline of body and head.
3. Counterbalance employed.
4. Backswing and swing-through.
5. Facing pins throughout approach.
6. Bending of forward knee.
7. Release of bowling ball.
8. Follow-through.

In each of the major areas of consideration, each subject in all three groups received a rating which ranged from a high of four to a low of one. A detailed discussion of the judges' ratings was presented on pages 47 to 55 in this chapter. Copies of the materials included in the bowling unit of instruction are included in the Appendix to this inquiry.

How the Movement Education Unit Was Taught

The unit of movement education was taught to the Delayed Experimental Group and the Experimental Group. During the first and second class sessions, for both experimental groups, the volunteers were screened for eligibility to serve as subjects according to the established criteria. The students were given an opportunity to select or reject the possibility of serving as subjects. Those students who decided to serve as subjects were requested to supply the investigator with information concerning: (1) Their full name, (2) Address, (3) Post office box number, (4) Telephone number, and (5) Their schedule for the next semester.

Because the movement education unit consisted of sixteen principles and five motor patterns which were presented to the two experimental groups within ten class hours, it was necessary to complete, at the very least, two principles or patterns, each class period. The investigator was aware that this was a considerable amount of material to be covered each class period; and, it was for this reason that each subject was given written information concerning the principles and patterns of movement two class sessions before the time that the assigned material would actually be presented in class.

It was, of course, impossible to cover all aspects of each selected principle and pattern of movement and this was never the intent of the investigator. The intent was to introduce, explain, demonstrate and allow the subjects some time to explore particular aspects of each principle and motor pattern. Subjects were encouraged to ask questions and time was taken to answer each question asked. Since it was critical that the subjects learn--rather than memorize--the material presented to them in written form, every effort was made by the investigator to bring this about through her explanations, demonstrations, planned explorations, and questions asked of subjects during the ten hours of instruction. An effort to emphasize points of major importance took the form of brief periodic quizzes over a limited number of movement principles (no more than four).

Both experimental groups completed the movement education unit after ten hours of instruction and the comprehensive written examination was administered during the following class session.

The Delayed Experimental Group

The volunteers who comprised the delayed experimental group were solicited from students already enrolled in the 4:30 P.M. Monday, Wednesday, and Friday, and the 4:00 P.M. Tuesday and Thursday, body mechanics classes in which the movement education unit was taught during the first semester of 1966-67. Additional volunteers from other classes in the required program of physical education were also included in these two established classes, which were taught by the investigator.

The movement education unit for the DE Group began January 3 for the 4:00 P.M. class and January 4 for the 4:30 P.M. class. Since one class met one hour a day three days a week and the other met an hour and thirty minutes a day, two days a wekk, it was not possible for the investigator to cover the same materials in each class session for both groups. It was possible and necessary to teach more material in the class which met for an hour and thirty minutes twice a week.

Due to the fact that this was the first time that the investigator had taught this particular movement education unit, it was difficult to determine the exact number of class hours it would require for completion. The investigator had originally set the time limit at eight hours of instruction, but this did not prove to be sufficient time to cover the required material. The time had to be increased to ten hours of instruction. This extension of time resulted in some apprehension for the investigator, because there were only eight hours of class sessions available. The only alternative available for possible additional class instruction was for the two groups of subjects to stay a little later each day, which they very graciously agreed to do. The additional time was strictly observed for both classes and the needed two hours were added fifteen minutes at a time for the

4:30 P.M. class and thirty minutes at a time for the 4:00 P.M. class.

The 4:30 P.M. Monday, Wednesday, and Friday class completed the movement education unit January 16 and took the comprehensive written examination over the movement education material on January 18. The 4:00 P.M. Tuesday and Thursday class completed the movement education unit January 12 and took the comprehensive written examination over the movement education material on January 17.

The Experimental Group

The subjects which comprised the Experimental Group were screened when they enrolled for the 4:30 P.M. Monday, Wednesday and Friday body mechanics class in which the movement education unit was taught by the investigator during the second semester of 1966-67.

During the first class session for this experimental group the students were further screened for eligibility as subjects. A general explanation was given concerning the experimental study being conducted by the investigator, and a thorough explanation was given concerning the criteria by which students were eligible to become subjects. At this time students were given an opportunity to withdraw as subjects, and a similar opportunity was presented at the subsequent class meeting.

The material in the movement education unit was presented to the subjects in this group in a manner as nearly identical as humanly possible, as it had been presented to the Delayed Experimental Group during the first semester, and the ten hours of instruction time was carefully observed.

The movement education unit for the E Group began February 8 and was completed March 1, the subjects in this group took the comprehensive written examination over the movement education material on March 3.

How the Bowling Unit of Instruction Was Taught

Each of the three groups (DE, E, and C) received the unit of bowling instruction taught by the investigator during the second semester of the academic year 1966-67. Before the bowling unit began, the investigator met with each of the groups during their designated meeting times in a classroom setting and explained the general procedures to be followed during the bowling instruction. At this time the investigator stressed how important it was for the students not to practice bowling until after the required twenty games had been recorded. During this first meeting, the necessary information on each subject was either checked for needed corrections or gathered for the first time. Subjects were given the written materials, prepared by the investigator, related to the bowling instruction unit; and, they were asked to read through the material at this time. The subjects were given time to read the section of the material concerning fundamentals of bowling. They were asked to re-read the material and learn it prior to the next class session, which was to be held at the bowling lanes.

The subjects were assigned each section of the bowling material at appropriate intervals, one class period in advance of the time that the information would be presented and covered in actual class instruction. As with the other unit of instruction, the subjects were encouraged to ask questions and time always was taken to answer all questions. Sometimes the question and answer was given to the entire group and sometimes it was done on an individual basis. The bowling instruction began as group instruction and gradually moved into individual instruction.

The bowlers were introduced to score keeping after six hours of instruction in bowling, and the first of the required twenty lines of bowling was recorded after completing twelve hours of instruction. From the first time the subjects began to keep score, the investigator checked the score sheets. First, checking the areas in which mistakes were being made; and later to determine the accuracy of the game score before it was officially recorded for each subject. The scores for each of the twenty games bowled by each subject were officially recorded on an individual tally sheet and on an individual graph. A graphic record also was kept of the progress of each of the three groups involved in the study. When twenty games of bowling had been completed the written examination concerning the application of movement principles was administered to the subjects.

The Delayed Experimental Group

The Delayed Experimental Group was designated to have a six week delay between the time they completed the movement education unit and the beginning of their unit of bowling instruction.

During the official university registration period the subjects enrolled in a 4:00 P.M. Tuesday and Thursday bowling class which was taught by the investigator during the second semester of the 1966-67 academic year. This class was established specifically for the DE Group.

During the first meeting of this group, at the beginning of the second semester, the investigator carefully explained to the subjects that they would have a six weeks delay before the bowling instruction would begin. They were told that they would receive a post card reminding them of the day on which the unit would begin. The investigator sent the post cards on March 1 and informed the subjects that the class would begin on March 7. On the designated date, thirty-seven subjects reported to class. For this group the bowling instruction began March 9 and was completed May 16.

The Experimental Group

The Experimental Group was the group designated to move immediately into the bowling instruction upon the completion of the movement education unit.

This group consisted of students who enrolled in a 4:30 P.M. Monday, Wednesday, and Friday body mechanics class taught by the investigator, during the second semester of 1966-67. The reader is reminded that the subjects in this group were screened, according to the established criteria, at the time they registered for the class and again during the first and second class sessions. During the first two class meetings the students were given the opportunity to reject the possibility of taking part in the study. The Experimental Group finished the movement education unit on March 3. The bowling instruction unit began on March 6 and was completed on May 15 for the Experimental Group.

The Control Group

The Control Group was the group designated to receive only the bowling instruction with no prerequisite unit of movement education.

During the official university registration period for the second semester of 1966-67, the investigator screened students wishing to enroll in the 2:30 P.M. Tuesday and Thursday, bowling class according to the criteria established in the research design. The students were screened again during the first class meeting of the second semester; and, they were given a thorough explanation of what would be expected of them as well as an opportunity to withdraw from the study. Again, at the next class meeting, students were given the opportunity to reject the possibility of serving as subjects in the experimental study.

The bowling unit of instruction for this group began February 9 and ended on May 9.

Treatment of the Data

To test the research hypotheses which were presented in detail in Chapter I of this dissertation, the investigator selected the statistical techniques which were appropriate as tests of significance for the data collected during the experiment. The .05 level of significance was selected as being indicative that the results obtained were due to the experimental conditions rather than factors of chance.

'Bartlett's test of the homogeneity of variance was selected as the method of determining whether variation of the three group variance for the initial bowling scores could be attributed to chance. The reader is referred to Du Bois[1] for a detailed description of the assumptions which necessitate the use of Bartlett's test and its computation.

Hypothesis No. 1 was tested according to the results of the statistical techniques employed to test each of the subsequent Hypotheses.

The investigator selected the analysis of variance

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[1]Philip H. Du Bois, An Introduction to Psychological Statistics (New York: Harper and Row Publishers, 1965), pp. 375-376.

to test Hypotheses No. 2 and No. 4. McNemar states:

> The F technique may be applied as a test of the significance of the difference between two or more means based on large or small samples of equal or unequal size (per group) regardless of whether there is an a priori basis for arranging the groups in order.[1]

The reader is referred to McNamar for a detailed description of this technique.

The t-test was selected by the investigator to test Hypotheses No. 3 and No. 5. McNemar states:

> When and only when F, as an over-all test, indicates significant difference among the groups, we may safely make further tests to see whether two selected means differ significantly or whether one mean (or the average of two or more group means) differ more than chance from the average of the other group means.[2]

The reader is referred to McNamar[3] for the procedures necessary in the computation of this statistical technique.

The Pearson's product moment correlation technique was applied to test Hypothesis No. 6 in order to determine the relationship between the final bowling scores and the scores which represented the application of mechanical principles. The application scores were the composite score of the final written and the judges' ratings. The t-test was applied to the coefficients of correlations in order to determine the significance of the difference between them.

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[1]Quinn McNemar, Psychological Statistics (New York: John Wiley and Sons, Inc., 1962), p. 270.

[2]Ibid., p. 269.

[3]Ibid., p. 285.

The reader is again referred to McNemar[1] for a description of this technique. Hypothesis No. 6 was further tested through the application of the analysis of variance to each of the following:

1. Difference between initial and final bowling scores.
2. Difference between initial and mid-point bowling scores.
3. Difference between mid-point and final bowling scores.
4. The final written scores.[2]

Pearson's product moment correlation technique was used in order to determine the reliability of the judges' ratings and this same technique, stepped up by the Spearman-Brown formula, was applied to determine the reliability of the written test.

Summary

The present investigation was designed to determine the effectiveness of a unit of movement education, taught as a prerequisite, upon the level of achievement in the specialized skill of bowling. In order for the experiment to yield data applicable to the purposes of the study, the

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[1] Ibid.

[2] Ibid., pp. 139-140.

investigator established definite procedures which were followed explicitly throughout the conduct of the study.

Specific procedures guided the investigator in phases of the study preliminary to the conduct of the experiment as well as during the experimental period. Additional procedures were established by the investigator relative to the analysis and interpretation of the data collected. In Chapter II, a detailed report of all procedures followed in the development of this study was presented.

Chapter III contains the complete analysis and interpretation of the data collected during the present study.

CHAPTER III

ANALYSIS AND INTERPRETATION OF THE DATA

The analysis and interpretation of the data collected during this experimental study are presented in this Chapter.

For the purposes of simplicity and clarity the analysis and interpretation of the data are presented in relation to each of the hypotheses which served as guides for the development of this inquiry.

Initial, Mid-Point, and Final Status of the Three Groups With Respect to Bowling Scores

Only those volunteers with no previous instruction in a unit of movement education who qualified as beginning bowlers were eligible to serve as subjects for this inquiry. A detailed explanation of the procedures followed in the selection of subjects was included in Chapter II of this manuscript.

The Delayed Experimental Group (DE) and the Experimental Group (E) participated in a prerequisite unit of movement education in which they were taught principles of movement specifically related to the specialized skill of bowling. The Control Group (C) did not receive this prerequisite unit of movement education. The written examination concerning the application of movement principles was administered to groups DE and E upon completion of the movement education unit and to group C prior to their participation in the unit of bowling instruction.

All three groups of students participated in the bowling instruction unit. The scores of the first three games of bowling were averaged to determine the initial score. The scores of the ninth, tenth, and eleventh games were averaged and designated as the mid-point score and the scores of the eighteenth, nineteenth, and twentieth games were averaged to ascertain the final score. The fifteenth game was designated as the starting point for the judges to begin their observations of the subjects' ability to apply movement principles to the fundamental skills necessary in bowling. The same written examination over the Movement Education Unit was administered to all three groups upon their completion of the bowling unit.

Table 1 depicts the mean scores and standard deviations of the initial, mid-point and final bowling scores of each of the three groups.

TABLE 1

INITIAL, MID-POINT, AND FINAL MEAN BOWLING SCORES
FOR THE THREE GROUPS OF SUBJECTS

Groups	N	Initial		Mid-Point		Final	
		Mean	SD	Mean	SD	Mean	SD
Experimental (E)	30	84.9555	15.8659	94.1778	14.8600	99.0000	16.7078
Delayed Experimental (DE)	33	85.5999	11.5487	88.7445	15.3774	98.0554.	14.6121
Control (C)	30	86.5221	13.3646	91.4444	15.2174	94.1556	11.7671

Examination of Table 1 indicates that the lowest initial mean score was achieved by the Experimental Group and the highest by the Control Group. The difference between the lowest and the highest score was 1.5666. Bartlett's test of homogeneity of variance was applied to the initial scores for each group in order to determine whether the variance among groups at the initial stage of the experiment was due to chance factors. Table 2 indicates the results of this test.

TABLE 2

SIGNIFICANCE OF THE CHI-SQUARE VALUE OF BARTLETT'S TEST OF HOMOGENEITY OF VARIANCE

Chi-Square Value	df	P
.227	2	NS

Note: Chi-square value required for significance at .05 level = 5.991.

Table 2 reveals that the chi-square value of .227 did not approach the value of 5.991 required for significance at the .05 level. This finding indicates that the three groups experienced only chance variance on their initial bowling score and, therefore, could be considered honogeneous with respect to their initial skill in bowling.

Analysis of the Data as They Relate to the Hypotheses

In an attempt to determine the effectiveness of a prerequisite unit of movement education upon the subsequent learning of the specialized skill of bowling, the investigator proposed several hypotheses to be tested through the development of this inquiry. Each hypothesis will now be presented with the pertinent data collected from the various sources utilized in this experiment.

Hypothesis 1

> "The Thorndike theory of specificity and the Judd theory of generalization are not opposing theories in their meanings for educational practices."

Upon examination of Tables 2, 3, 4, and 17, pages 89, 91, 93, 103 respectively, the following information becomes apparent:

1. The three groups of subjects (Experimental, Delayed Experimental, and Control) involved in the study experienced only chance variance on the initial bowling scores.

2. No one group scored significantly higher on the mid-point bowling scores than did either of the other two groups.

3. No one group scored significantly higher on the final bowling scores than did either of the other two groups.

4. The difference between the initial and final

bowling scores for the three groups was not significant at the .05 level.

Hypothesis 2

"Students beginning the bowling unit one week after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education unit and/or the students beginning the bowling unit one month after the completion of the movement education unit."

Table 3 illustrates the results of an analysis of variance using the means of the mid-point bowling scores for all three groups.

TABLE 3

ANALYSIS OF VARIANCE OF MEAN SCORES AMONG THE THREE GROUPS AT THE MID-POINT OF THE BOWLING UNIT

Source of Variance	Sum of Squares	df	Mean Squares	F	P
Between Groups	386.29	2	193.145	.8232	NS
Within Group	21115.2	90	234.61		
Total	21501.49	92			

Note: F value of 4.85 required for .01 level of significance.
F value of 3.10 required for .05 level of significance.

Examination of Table 3 reveals that the F value of .8232 is not significant at the .05 level. This result indicates that no one group scored significantly higher on the mid-point bowling scores than did the other two groups.

Hypothesis 3

> "Students beginning the bowling unit one month after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education unit."

According to the results of the analysis of variance, illustrated in Table 3, there was no significant difference between the mid-point scores for groups Delayed Experimental and Control. Table 3 indicates that the Delayed Experimental Group had a lower mid-point score than did the Control Group; however, it was not significantly lower.

Hypothesis 4

> "Students beginning the bowling unit one week after the completion of the movement education unit will achieve a higher final bowling score than will the students who do not receive the movement education unit and/or the students beginning the bowling unit one month after the completion of the movement education unit."

Table 4 depicts the results of an analysis of variance using the means of final bowling scores for each of the three groups.

Scrutiny of Table 4 reveals that the $\underline{F}$ value of 1.008 is not significant at the .05 level. This result indicates that no one group was significantly higher on their final bowling score than were the other groups.

TABLE 4

ANALYSIS OF VARIANCE OF FINAL MEAN SCORES AMONG THE THREE GROUPS IN BOWLING

Source of Variance	Sum of Squares	df	Mean Squares	*F*	P
Between Groups	431.07	2	215.535	1.008	NS
Within Groups	19253.12	90	213.923		
Total	19684.19	92			

Note: *F* value of 4.85 required for .01 level of significance.
F value of 3.10 required for .05 level of significance.

Hypothesis 5

"Students beginning the bowling unit one month after the completion of the movement education unit will achieve higher final bowling scores than will the students who do not receive the movement education unit."

Referring to the results of the analysis of variance, presented in Table 4, the final bowling scores for the Delayed Experimental Group were not significantly higher than the final scores for the Control Group. As reported in Table 1, page 88, the final bowling scores for the Delayed Experimental Group were higher than the scores for the Control Group, but not significantly higher.

Hypothesis 6

> "The application of mechanical principles to the specialized skill of bowling will affect bowling scores favorably."

In order to test Hypothesis 6, a number of variables were included in the basic research design, as indicated in Chapter II of this manuscript. In addition to the bowling scores, an appraisal was made of each subject's understanding of the mechanical principles of movement through a written examination; and, her ability to physically apply these principles while bowling was determined by three trained judges who observed and rated her during the final phase of the bowling unit.

The reliability of the judges' ratings and the written examination over the movement education unit was determined prior to additional statistical treatment of these data. An analysis of these data are presented in the ensuing pages.

As explained in Chapter II, pages 49 and 50, the judges were considered to be reliable and in agreement according to the results of the rank order correlation applied to the data collected during the orientation program conducted for the three judges. Tables 5, 6, and 7 reveal the reliability of the judges' ratings, for the ninety-three subjects, according to the results of the Pearson product-moment correlation. This method was used in preference to the Spearman rank-difference because of the large number of subjects involved.

TABLE 5

COEFFICIENT OF CORRELATION BETWEEN RATINGS OF JUDGES X AND Y

Variable	Mean	SD	df	*r*	P
Judge X	17.9247	4.4727	91	.527	>.01
Judge Y	14.3441	5.0364			

Note: *r* value required for significance with 91 df:
.05 level = .2050
.01 level = .2673

According to Table 5, Judges X and Y were in agreement. They had a very high positive correlation which was significant at better than the .01 level.

TABLE 6

COEFFICIENT OF CORRELATION BETWEEN RATINGS OF JUDGES X AND Z

Variable	Mean	SD	df	*r*	P
Judge X	18.4194	3.6701	91	.198	NS
Judge Z	18.0430	4.6718			

Note: *r* value required for significance with 91 df:
.05 level = .2050
.01 level = .2673

Table 6 indicates that Judges X and Z were not always in agreement. Their ratings did correlate positively but the correlation was not significant in that it was less than the .05 level.

TABLE 7

COEFFICIENT OF CORRELATION BETWEEN RATINGS OF JUDGES Y AND Z

Variable	Mean	SD	df	r	P
Judge Y	14.7312	4.6261	91	.214	.05
Judge Z	18.0538	4.6729			

Note: r value required for significance with 91 df:
.05 level = .2050
.01 level = .2673

An examination of Table 7 reveals that Judges Y and Z showed a positive relationship in their ratings, significant at the .05 level.

The written test over the movement education unit was administered twice to each of the three groups during the process of this study. The first administration was at the completion of the movement education unit, for the two experimental groups, and prior to the bowling unit for the Control Group. The same written test was administered the second time to all three groups of subjects upon completion of the unit of bowling instruction. Both times the reliability coefficient was calculated using the "split-half" method, stepped up by the Spearman-Brown Prophecy Formula.

Table 8 presents the reliability coefficient of the initial written test and Table 9 indicates the correlation coefficient of the final written test.

TABLE 8

COEFFICIENT OF CORRELATION BETWEEN INITIAL WRITTEN TEST (EVEN) AND INITIAL WRITTEN TEST (ODD)

Variable	Mean	SD	df	r	P
Initial Test (Odd)	10.0323	3.1399	91	.693	>.01
Initial Test (Even)	10.0430	2.7782			

Note: r value required for significance with 91 df:
.05 level = .2050
.01 level = .2673

The reliability coefficient for the initial test was significant at better than the .01 level.

TABLE 9

COEFFICIENT OF CORRELATION BETWEEN FINAL WRITTEN TEST (EVEN) AND FINAL WRITTEN TEST (ODD)

Variable	Mean	SD	df	r	P
Final Test (Odd)	9.9824	2.7337	91	.734	>.01
Final Test (Even)	10.3441	2.6171			

Note: r value required for significance with 91 df:
.05 level = .2050
.01 level = .2673

The coefficient of reliability for the final written test was also significant at better than the .01 level.

It may be assumed that the written examination over the movement education unit was a highly reliable test.

For the purpose of reader reference, the mean scores of the initial and final written examination over the movement education unit are shown in Table 10 and the results of the judges' ratings of the students during the bowling unit are revealed in Table 11.

TABLE 10

INITIAL AND FINAL MEAN SCORES FOR THE THREE GROUPS ON THE WRITTEN EXAMINATION OVER THE MOVEMENT EDUCATION UNIT

Groups	N	Initial		Final	
		Mean	SD	Mean	SD
Experi-mental	30	21.0667	3.5396	21.2333	3.4707
Delayed Experi-mental	33	23.3333	5.1532	23.3333	4.1979
Control	30	15.2667	4.1064	16.4000	3.4795

TABLE 11

MEAN SCORES OF THE JUDGES' RATINGS FOR THE THREE GROUPS

Groups	N	Mean	SD
Experimental	30	53.3666	10.0813
Delayed Experimental	33	49.8333	8.3190
Control	30	45.7666	11.6209

In an attempt to determine the maximum ability of the subjects to make the application of learned movement principles to the actual motor task of bowling, the investigator combined the scores for the final written test (intellectual application) and the scores for the judges' ratings (physical application of knowledge) and labeled this score the composite score for application.

Table 12 divulges the coefficient of correlation between the final bowling scores and the composite application scores for the Experimental Group.

Table 12, page 100, reveals that the correlation coefficient of .0395, with twenty-eight degrees of freedom, is not significant at the .05 level. This means that the relationship between the final bowling scores and the composite application scores for the Experimental Group was not significant.

TABLE 12

COEFFICIENT OF CORRELATION BETWEEN FINAL BOWLING SCORES AND THE COMPOSITE SCORES OF FINAL WRITTEN AND JUDGES' RATINGS FOR THE EXPERIMENTAL GROUP

Variable	Mean	SD	df	r	P
Final Bowling	99.0000	16.7078	28	.0395	NS
Final Written and Judges' Ratings	74.5000	11.3365			

Note: r value required for significance with 28 df:
.05 level = .374
.01 level = .478

Table 13 relates the coefficient of correlation between the final bowling scores and the composite application scores for the Delayed Experimental Group.

TABLE 13

COEFFICIENT OF CORRELATION BETWEEN FINAL BOWLING SCORES AND THE COMPOSITE SCORES OF FINAL WRITTEN AND JUDGES' RATINGS FOR THE DELAYED EXPERIMENTAL GROUP

Variable	Mean	SD	df	r	P
Final Bowling	98.50497	14.2751	31	.0164	NS
Final Written and Judges' Ratings	73.2727	8.60329			

Note: r value required for significance with 31 df:
.05 level = .355
.01 level = .456

This table indicates that the correlation coefficient of .0164, with thirty-one degrees of freedom, is not significant at the .05 level of confidence. Therefore, there was no significant relationship between final bowling scores and the composite application scores for the Delayed Experimental Group.

Table 14 discloses the coefficient of correlation between the final bowling scores and the composite application scores for the Control Group.

TABLE 14

COEFFICIENT OF CORRELATION BETWEEN FINAL BOWLING SCORES AND THE COMPOSITE SCORES OF FINAL WRITTEN AND JUDGES' RATINGS FOR THE CONTROL GROUP

Variable	Mean	SD	df	_r_	P
Final Bowling	94.1556	11.7671	28	.2904	NS
Final Written and Judges' Ratings	67.0000	10.6583			

Note: _r_ value required for significance with 28 df:
.05 level = .374
.01 level = .478

As reported in Table 14, the correlation coefficient of .2904, with twenty-eight degrees of freedom, is not significant at the .05 level. Thus, it may be assumed that there was no significant positive relationship between the final bowling scores and the composite application scores for the Control Group.

Tables 15, 16 and 17 present the results of testing for the significance of the coefficient of correlation obtained when comparing final bowling scores and composite application scores of each group with the other two groups of subjects.

TABLE 15

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
r's FOR GROUP E AND GROUP C

Groups	*r*	*Z*	df	t-value	
				t	P
Experimental (E)	.039	.040	58	.95	NS
Control (C)	.290	.299			

Note: *t*-value required for significance with 58 df:
.05 level = 2.000
.01 level = 2.660

TABLE 16

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
r's FOR GROUP DE AND GROUP C

Groups	r	z	df	t-value	
				t	P
Delayed Experimental (DE)	.016	.020	61	1.052	NS
Control (C)	.290	.299			

Note: t-value required for significanec with 61 df:
.05 level = 2.000
.01 level = 2.660

TABLE 17

SIGNIFICANCE OF THE DIFFERENCE BETWEEN
r's FOR GROUP E AND GROUP DE

Groups	r	z	df	t-value	
				t	P
Experimental (E)	.039	.040	61	.075	NS
Delayed Experimental (DE)	.016	.020			

Note: t-value required for significance with 61 df:
.05 level = 2.000
.01 level = 2.660

The obtained t-values, as reported in Tables 15, 16 and 17, indicate that there was no significant relationship between the final bowling scores and the composite application scores among the three groups of subjects.

Table 18 imparts the results of the analysis of variance employed to determine the significance of the difference between the means of the initial and the final bowling scores for all three groups.

TABLE 18

ANALYSIS OF VARIANCE OF THE DIFFERENCE BETWEEN INITIAL AND FINAL BOWLING SCORES FOR THE THREE GROUPS OF SUBJECTS

Source of Variance	Sum of Squares	df	Mean Squares	*F*	P
Between Groups	994.509	2	497.2545	2.3110	NS
Within Groups	19365.402	90	215.171		
Total	20359.911	92			

Note: *F* value of 4.85 required for .01 level of significance.
F value of 3.10 required for .05 level of significance.

Upon inspection of Table 18, it becomes apparent that the obtained *F* value of 2.310 for the differences between the initial and final bowling scores for the three groups was not significant at the .05 level.

The reader is referred to Table 19, in which the gains in bowling score means are illustrated.

TABLE 19

GAINS BETWEEN BOWLING SCORE MEANS FOR THE THREE GROUPS OF SUBJECTS

Group	Initial to Mid-Point	Mid-Point to Final	Initial to Final
Experimental (E)	9.2220	4.8222	14.0445
Delayed Experimental (DE)	3.1448	9.3107	12.4555
Control (C)	4.9223	2.7112	7.6335

On Table 19 it may be observed that the Experimental Group made the greatest improvement in bowling scores, 14.0445; the Delayed Experimental Group's improvement in bowling scores was only 1.5890 less than that of the Experimental Group. The Control Group's bowling improvement was 6.4110 less than that of the Experimental Group's improvement and 4.8220 less than the Delayed Experimental Group's. The Experimental Group experienced the greatest improvement in bowling from the initial to the mid-point period. This group continued to improve from the mid-point to final scores; however, the rate of improvement declined somewhat. The Experimental Group exhibited the greatest total gain in bowling scores and upon completion of the required twenty games had the highest bowling scores. However, neither the gains nor the scores were significantly greater than those of the other two groups.

The Delayed Experimental Group showed less improvement from the initial to the mid-point period than either of the other two groups. This group experienced the greatest improvement from their mid-point to their final scores. The difference between the final scores for the Delayed Experimental Group as compared to the Experimental Group was only .9446 and as compared to the Control Group was 3.8998. Neither the gains nor the scores were significantly greater than those of the other two groups.

The Control Group started with a slightly higher initial bowling score than the other two groups, but this group displayed the least improvement throughout the experiment. Upon completion of the required twenty games the Control Group revealed the lowest scores. It is, however, imperative to point out that the final scores for the Control Group were not significantly lower than the final scores for the other two groups.

A summary of the means of pertinent data related to Hypothesis 6 may be observed in Table 20. The reader is reminded that the differences between and among the means of the three groups were not significant.

TABLE 20

SUMMARY OF MEANS

Group	N	Bowling Scores			Judges' Ratings	Written Test	
		Initial	Mid-Point	Final		Initial	Final
Experimental (E)	30	84.9555	94.1778	99.0000	53.3667	21.0667	21.2333
Delayed Experimental (DE)	33	85.5999	88.7445	98.0554	49.8333	23.3333	23.3333
Control (C)	30	86.5221	91.4444	94.1556	45.7667	15.2667	16.4000

Summary

In Chapter III the writer presented the analysis and interpretation of the data obtained during this inquiry. Following the statement of each of the hypotheses, pertinent data were presented in tabular form accompanied by discussion. The reliability of the judges' ratings and the written examination over the movement education unit were presented, also.

Chapter IV will include a summary of the experimental study, the conclusions drawn according to the results of the analysis of data, implications of the findings, and recommendations for future studies.

CHAPTER IV

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS FOR FUTURE STUDIES

This chapter includes a summary of the investigation, a synopsis of the data as they pertain to the hypotheses, conclusions and implications based upon the findings, and recommendations for future studies.

Summary of the Investigation

The most recent and most widely accepted theory concerning human learning implies that the physical aspects of an individual constitute the process through which learning takes place and the intellectual aspects represent the extent, or the results, of the process.[1,2]

The conclusions of studies conducted by psychologists prior to the 1930's relate that human performance and learning are based upon reaction to discrete sensory stimuli and that learning depends upon the strengthening of the bonds between stimuli and the responses of the organism. Since the 1930's, psychology theorists have maintained that stimuli within the environment are organized into patterns and that

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[1]Kaelin, _op. cit._, p. 99.

[2]Oberteuffer and Ulrich, _op. cit._

the resulting performance is based upon the meaning attached to the total field of experience. Research findings indicate that a two-factor theory of motor performance can be supported. The two-factor theory contends that there are several groups of general abilities which are essential or fundamental to performance. These abilities are largely independent of each other, but, they contribute to the execution of several groups of skills. These general abilities include: (1) Efficient utilization of space in accurate movement, (2) The ability to summon and to exert maximum force and speed when needed, (3) Freedom from excess tension, (4) Motivation, and (5) The ability to analyze a complex task.

It would appear, according to current beliefs, that the purpose of education is to continuously strive for more refined, highly developed, and specialized behavioral patterns of human conduct. How fully developed an individual becomes depends upon educators' ability to see all of the necessary components involved in this developmental process. The cultural needs of a society change from time to time as that society moves through the process of civilization. Education must not only prepare individuals to cope with the future but, more important, to be able to fashion it in a manner which not only meets human needs but challenges the best capacities of man.

The basic premise of movement education, as stated by Broer, is:

> Movement is used in some way to some degree, in every task accomplished by human beings. The need of every individual is to understand human movement so that any task, light or heavy, fine or gross, fast or slow, long or short duration, whether it involves everyday living, work, or recreational skills can be approached effectively.[1]

Movement becomes significant to an individual through a knowledge about the body and through an awareness of self, which develops through moving the body. The major areas of concern in movement education are:

1. Development of physical qualities necessary to effective movement.
2. Development of an awareness of the principles which are involved in human movement.
3. Development of an understanding of how these principles affect movement.
4. Development of basic movements.
5. Application of mechanical principles and combining basic movements to develop fundamental motor patterns which may be modified as needed in order to develop specialized skills which relate specifically to a particular activity.

Cardinal to the theory of movement education is the premise that the physical laws of motion which govern all

[1]Broer, Efficiency of Human Movement, p. 3.

movement also govern human movement. This theory also implies that the specialized skills which make up all the various physical activities involve the use of the same fundamental movements and motor patterns, modified according to the specific purpose of the particular activity. Therefore, it would seem that if the physical principles of movement are learned and understood, applications can and/or should develop, which would facilitate all motor skill learning. The process of transfer of learning is a complex, complicated, interdependent functioning of all the various factors; and, continued study and research is necessary before it can be fully understood.

Purpose of the Study

The general purpose of this inquiry was to determine if participation in a prerequisite unit of movement education would effect a higher level of achievement in the specialized skill of bowling than would specialized skill instruction without instruction in the unit of movement education. The three groups of subjects established in the research design of this study were:

1. The Delayed Experimental Group: Received the prerequisite unit of movement education and had a six weeks delay before beginning the unit of bowling instruction.

2. The Experimental Group: Received the prerequisite instruction in movement education and moved immediately into the bowling instruction unit.

3. The Control Group: Received no specific instruction in movement education and participated only in the unit of bowling instruction.

The following hypotheses were tested through the development of this study:

1. The Thorndike theory of identical elements and the Judd theory of generalization are not opposing theories in their meanings for educational practices.

2. Students beginning the bowling unit one week after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education unit and/or the students beginning the bowling unit six weeks after the completion of the movement education unit.

3. Students beginning the bowling unit six weeks after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education unit.

4. Students beginning the bowling unit one week after the completion of the movement education unit will achieve a higher final bowling score than will the students who do not receive the movement education unit and/or the students beginning the bowling unit six weeks after the completion of the movement education unit.

5. Students beginning the bowling unit six weeks after the completion of the movement education unit will achieve higher final bowling scores than will the students who do not receive the movement education unit.

6. The application of mechanical principles to the specialized skill of bowling will affect bowling scores favorably.

Method of Inquiry

Chapter II of this manuscript dealt exclusively with a detailed explanation of the procedures followed in the development of the study. This information was presented under the major headings of sources of data, development of the unit of movement education, development of the unit of bowling instruction, how the movement education unit was taught, how the bowling unit of instruction was taught, and treatment of the data.

The subjects who volunteered as participants in this inquiry were ninety-three undergraduate students enrolled in the Texas Woman's University in Denton, Texas, during the first and second semesters of the academic year of 1966-1967. Only students with no previous instruction in a unit of movement education and who qualified as beginning bowlers were allowed to serve as subjects.

The first phase of the study consisted of the instruction in movement education which was received by the

Delayed Experimental Group and the Experimental Group. The movement education unit, as well as the bowling unit, was taught by the investigator and was as nearly identical as humanly possible for each group with respect to length of time for the presentation of the unit, the materials presented, the methods of instruction, and the actual presentation. The movement principles taught were limited to those which had direct or indirect application to the specialized skill of bowling. The movement principles selected for inclusion in the unit of movement education were: gravity, center of gravity, balance, motion, friction, force, centrifugal force, parallelogram of force, momentum, absorbing force, axes of rotation, levers, moment of inertia in angular motion, air resistance, and spin. The motor patterns selected for inclusion in the unit of movement education were: standing, balancing weight on one foot, walking, holding and carrying, and the underhand throwing pattern.

The second phase of the experiment consisted of the instruction in bowling which was received by all three groups of subjects. The bowling unit of instruction included exposure to an understanding and application of: basic movements necessary in bowling; physical laws of motion--those related to human movement (body mechanics) and those related to the objects involved in bowling (mechanical principles); fundamental motor patterns which are necessary in bowling; and a brief explanation of the history, rules, terminology, and score keeping. To facilitate learning, the following procedures were adhered to: (1) Only four bowlers were assigned to a lane, (2) Individual instruction and assistance was provided after the initial period of group instruction, (3) A minimum of rules were presented, and (4) Individual tally sheets and graphs of learning curves were available for student reference.

Data were collected in the form of performance scores on: (1) Initial and final written examinations over the movement education unit, (2) Initial, mid-point, and final scores accumulated during twenty games of bowling, and (3) Judges' ratings of each subject's ability to apply eight mechanical principles of movement utilized in bowling. The data collected from the initial bowling scores were subjected to Bartlett's test of homogeneity of variance in order to test the homogeneity of the three groups.

The analysis of variance was utilized to test the significance of the difference in mid-point bowling scores among the three groups of subjects. This same statistical procedure was utilized to test the significance of the difference in final bowling scores among the three groups. The analysis of variance was used also to test the significance of the improvement between initial and final bowling scores among the three groups.

Pearson's product moment correlation technique was employed to determine the relationship between the final bowling score and the composite score, representing the written examination and the judges' ratings. This same statistical procedure was used in order to determine the reliability of the judges' ratings and this technique, stepped up by the Spearman-Brown formula, was applied to determine the reliability of the written examination.

Synopsis of the Data

A summary of the findings resulting from the analysis and interpretation of the data is presented in relation to the hypotheses tested.

Hypothesis 1

> "The Thorndike theory of identical elements and the Judd theory of generalization are not opposing theories in their meanings for educational practices." Accepted.

There was no significant difference in the performance of either of the experimental groups, in which the theory of generalization was utilized, as compared to the performance of the control group, in which the theory of specificity was utilized.

1. There was no significant difference between the mid-point bowling scores of either of the experimental groups as compared to the mid-point scores of the control group. (Table 3.)

2. There was no significant difference between the final bowling scores of either of the experimental groups as compared to the final scores of the control group. (Table 4.)

3. There was no significant difference in the amount of improvement from the initial bowling score to the final bowling score among the three groups. (Table 18.)

Hypothesis 2

> "Students beginning the bowling unit one week after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education unit and/or the students beginning the bowling unit six weeks after the completion of the movement education unit." Rejected.

Group E did achieve higher mid-point bowling scores than did groups DE and C; however, these scores were not significantly higher. (Table 3.)

Hypothesis 3

> "Students beginning the bowling unit six weeks after the completion of the movement education unit will achieve higher bowling scores at the mid-point of the bowling unit than will the students who do not receive the movement education." Rejected.

Group DE achieved lower mid-point bowling scores than did Group C; however, these scores were not significantly lower. (Table 3.)

Hypothesis 4

> "Students beginning the bowling unit one week after the completion of the movement education unit will achieve a higher final bowling score than will the students who do not receive the movement education unit and/or the students beginning the bowling unit six weeks after the completion of the movement education unit." Rejected.

Group E did achieve a minutely higher final bowling score than did Group DE and a slightly higher final score than Group C. The difference in final bowling scores among the three groups was not significant. (Table 4.)

Hypothesis 5

> "Students beginning the bowling unit six weeks after the completion of the movement education unit will achieve higher final bowling scores than will the students who do not receive the movement education unit." Rejected.

Group DE did obtain slightly higher final bowling scores than did Group C; however, the difference was not significant. (Table 4.)

Hypothesis 6

> "The application of mechanical principles to the specialized skill of bowling will affect bowling scores favorably." Rejected.

The final written test score combined with the judges' rating constituted the application score. The positive correlation coefficient between the application score and the final bowling score was not significant for any of the three groups of subjects. (Tables 15, 16, and 17.)

Conclusions

Conclusions based on the findings of this inquiry, with all details stripped away, may now be stated as follows:

1. Prerequisite instruction in mechanical principles of movement had no appreciable effect upon college women's ability to achieve a higher level of performance in bowling, over a period of twenty games, than students who did not have such instruction during the present investigation.

2. It would appear that the longer the subjects were delayed between their instruction in mechanical principles of movement and the opportunity to make application of this knowledge to the performance of the specialized skill of bowling, the longer it took for them to demonstrate improvement in the skill. This delay, however, was not a significant detriment at the mid-point or final period of scoring.

3. Application of mechanical principles of movement in the actual performance of motor patterns utilized in bowling, as rated by trained judges, was not significantly effected by a prerequisite unit of instruction in movement education.

4. Knowledge of mechanical principles of movement, as expressed through a written examination over these principles, appeared to be learned through specialized skill instruction in bowling as adequately as through prerequisite

instruction in a unit of movement education in this investigation.

5. The written examination over the unit of movement education was a reliable instrument.

Implications

The following implications are based upon the data collected during this inquiry and upon the investigator's empirical observations of the students' verbalized and nonverbalized actions and reactions during the process of the study.

1. It appears that college women require a period of time to recall and apply general principles of movement to specialized motor performance. The group of subjects who had a six weeks delay between the prerequisite unit of movement education and the bowling unit were somewhat slower in showing improvement in bowling scores between the initial and mid-point scoring periods but seemed to make rather rapid strides between the mid-point and final periods. Although no significant differences were found to exist between the scoring periods among the three groups of subjects, curiosity prompts this investigator to wonder if the bowling unit had been continued over a longer period of time than utilized in this investigation, if significant differences might have been found to exist among the bowling scores of the three groups.

2. The subjects who received the prerequisite instruction in movement education seemed to evidence a better overall understanding of the skills necessary to bowling. During the time they were at the bowling alley for class, they were more aware of their mistakes and the ways to correct them. They became very cognizant of the fact that even though they knew what they should be doing it was not always possible for them to actually perform according to this knowledge. Concern and frustration were expressed at not being able to perform particular motor tasks as they should be performed. The subjects who did not receive the movement education were not as aware of their mistakes or the ways of correcting them as were the subjects in the experimental groups. They expressed less concern and frustration over their inability to perform the motor tasks successfully.

In this inquiry, the extent of a subject's ability to make application of the mechanical principles of movement to the specialized skill of bowling was determined by her bowling scores, judges' ratings, and scores on a written examination. On the basis of the findings of this inquiry, it is the investigator's belief that another approach for determining the application of knowledge of mechanical principles of movement should be considered in future studies designed to measure the effectiveness of instruction in movement education as it relates to specialized skill instruction.

One such approach, which would be particularly useful in a program of professional preparation, would be to have the subjects rate other performers with respect to their use of principles of movement in their execution of the specialized skill and compare these ratings with the observations of trained judges.

3. Although in theory it would appear that knowledge of the mechanical principles of movement would aid a college woman in improving her performance in a specialized motor skill involving these principles of movement, the findings of this investigation do not warrant such an assumption for the specialized skill of bowling. Administrators and instructors in required programs of physical education for women at the college level must determine if the time required for a prerequisite unit of movement education can be justified on some other basis than a significant increase in specialized skill performance in an activity such as bowling.

Recommendations for Future Studies

The findings of this study have posed additional questions for the investigator which brought about the following recommendations for future studies concerning a prerequisite unit of movement education and specialized skill instruction and/or performance.

1. A study designed to determine the effect of a prerequisite unit of movement education upon the level of achievement in a specialized skill after a delay of a year and a half.

2. A study designed to determine the effect of a prerequisite unit of movement education upon the level of achievement in a specialized skill with no formal class instruction in the specialized skill.

3. A study which would result in a valid and reliable written test which would adequately evaluate intellectual application of movement principles to everyday movement patterns utilized by women.

4. A study designed to develop a valid and reliable instrument for adequate evaluation of the application of movement principles to actual motor performance.

5. A study similar in design to the present inquiry with the specialized skill instruction unit extended to thirty games of bowling.

6. A study to determine the effectiveness of having students of movement education rate other performers with respect to their application of movement principles in specialized skills such as bowling, golf, rifle shooting, and archery.

7. A longitudinal study to determine the effectiveness of instruction in movement education at the elementary

school level as it relates to specialized skill acquisition at the high school and/or college level.

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APPENDIX

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MOVEMENT PRINCIPLES

I. GRAVITY

A. DEFINITION

Constant force pulling all objects downward.

B. IMPORTANCE

1. It is constant and universal.
2. Affects all objects.
3. It is always vertical.

C. FACTORS

1. Is proportional to the mass.
2. Falling objects experience gravitational acceleration.
3. Gravity may be overcome, matched, or yielded to.
4. Requires constant work from muscles to offset effects.

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II. CENTER OF GRAVITY

A. DEFINITION

The center of the mass.

B. IMPORTANCE

The location determines ease of balance.

C. FACTORS

1. The center of gravity changes with movement of body parts.

2. The center of gravity is determined at the point of intersection of 3 planes of weight halves.

   a) Transverse. (horizontal—top and bottom)

   b) Frontal. (frontal and back)

   c) Sagittal. (down the center—two sides)

3. The location of the center of gravity determines whether the object can be balanced.

4. The center of gravity in the adult human body is usually within the area of the hips.

5. In any rigid symmetrical body, the geometrical center is also the center of gravity.

6. No matter how irregular the shape of an object it has a point about which it will balance.

7. Large shoulders and shoulder muscles make the center of gravity high in men.

8. Large, fatty hips and thighs make the center of gravity low in women.

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III. BALANCE - (equilibrium)

A. DEFINITION

A state of poise, remaining position or stability, or equal distribution of weight.

B. IMPORTANCE

1. Steady position for work.
2. Economy of energy expenditure.
3. Safety.

C. FACTORS

1. The larger the base the more stable the object.
   The base should be enlarged in the direction of the opposing force. If the base is enlarged it should be done in such a way that movement of the joints is not restricted or strain put on any joint.
2. The smaller the base the less stable the object becomes.
3. An object is balanced when its center of gravity is over its supporting base.
4. If the line of gravity falls near the center of the base, the more stable the object becomes.
5. The lower the center of gravity, the more stable the object.
6. A small base and a high center of gravity reduce stability.
7. The heavier an object, all other things being equal, the greater the stability.
8. Balance in all activities is an active process, one in which muscles are attempting to control the center of gravity of the body in relation to the supporting base.

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IV. MOTION - (movement or action)

A. DEFINITION

The process of moving or changing place or position. A situation in which the position of an object and its support is changing.

B. IMPORTANCE

Motion produces momentum, or kinetic energy. In the human body, motion varies from fine movements, with little physical work being performed, to gross movements which involve the entire body in heavy work and re-resistance.

C. FACTORS MODIFYING MOTION

1. Friction.

2. Air resistance.

3. Water resistance.

4. Gravity.

D. NEWTON'S LAWS OF MOTION

1. Law of Inertia - (resistance to motion or change of motion)

a) A resting body will remain at rest if no external force operates upon it.

b) A body moving with uniform motion will retain this state of uniform motion as long as there is no external force operating upon it.

2. Law of Acceleration

Acceleration is -

a) Directly proportional to the mass of the body, and

b) In the same direction as the force producing it.

3. Law of Counterforce

Every force which meets resistance has an equal and opposite counterforce.

E. TYPES OF MOTION

1. Translatory - (linear)

An object moving as a whole in the direction of the motion, all parts move in a straight line and at an equal distance.

2. Rotatory - (angular)

There is one point within an object which serves as a center, about which all other points in the object outline a concentric arc.

Motion is <u>not</u> always strictly linear or rotatory, often it is a combination of the two.

F. FACTORS

1. Muscles of the body produce the force for most of man's movements.
2. Force behind or distributed around the center of gravity produces linear motion.
3. Force applied away from the center of gravity produces angular motion.
4. The mass of an object determines the degree of inertia, amount of acceleration from a given force, and amount of counterforce necessary.

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V. FRICTION

A. DEFINITION

Resistance between two surfaces where one is sliding or rolling on the other.

B. IMPORTANCE

1. Makes motion possible by resistance or counterforce (angular).

2. Makes motion possible by absence of resistance (linear).

C. FACTOR

1. A heavy object obtains greater friction than a light one.

2. A large surface provides better friction than a small one.

3. Forces directing the object against the other surface increase friction, those pulling the object may decrease friction.

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VI. FORCE

A. DEFINITION

Strength or power exerted upon an object; impetus or intensity of effect.

B. IMPORTANCE

Force is anything which produces motion or change of motion. Force as it applies to work must take into consideration:

1. Magnitude.
2. Direction of application.
3. Point of application.

C. THE MAJOR TYPES OF FORCE WHICH CAUSE THE HUMAN BODY TO MOVE ARE:

1. Internal—produced by the body itself.
2. External—applied by another person or object and by the downward pull of gravity.

D. FACTORS

1. In the human body force is supplied by the muscles which are innervated by the nerves.
2. Muscles only exert force by shortening, thus force exerted by muscles is a pull.
3. The desired outcome must be considered, whether it requires maximum force or controlled application of force.
4. The greatest total force can be attained only when all of the body parts that can contribute to the desired movement are used to their maximum.
5. Strong muscles can exert more force than weak muscles.

6. The strongest muscle available should be used in order to avoid strain.
7. Muscles work more efficiently when they begin on a stretch.
8. Unless there is a firm base for action force is not effective in moving an object (friction between the feet and the ground).
9. If force is applied to an object through its center of gravity less force is required to move the object and linear motion will result.
10. An object tends to rotate if force is applied above, below, or on either side of the center of gravity.
11. The farther from the center of gravity the force is applied the less force it takes to rotate the object.
12. The amount of force depends upon the ~~deviation~~ duration as well as the magnitude of the force.
13. Force must be absorbed or spent gradually. An absorbent surface must be provided for the impact (as in landing from a fall, landing from a jump, or catching).
14. The effectiveness of force, when used with levers is determined by:

    a) Distance of the point of application from the axis.

    b. The angle of application.

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VII. CENTRIFUGAL FORCE - (tangential force)

A. DEFINITION

Tendency of an object in the process of rotation to go off on a tangent to the arc of rotation.

B. IMPORTANCE

1. Many throws depend upon this effort.
2. Is a form of moving inertia.
3. May be a safety hazard.

C. FACTORS

1. There must always be a resisting force to prevent tangential action.
2. The greater the speed of angular action the greater the centrifugal force.
3. Timing of release determines accuracy.

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VIII. PARALLELOGRAM OF FORCE

A. DEFINITION

The vertical and horizontal lines are in proportion to a force applied at an angle to an object. The resultant of the application of force.

B. IMPORTANCE

1. Determines the direction in which the object will move.

2. Determines the effectiveness of the force and ease of motion.

C. FACTORS

1. A diagonal force applied to an object is in effect the resultant of two forces.

   a) When pulling an object with a diagonal rope, two forces are being exerted.

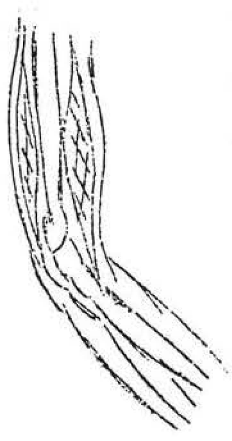
      (1) One in the direction of the desired movement (forward).

      (2) The other upward.

   b) Whether or not the upward force is desirable depends upon the amount of friction to be overcome.

   c) The greater the friction the more upward motion is needed.

2. In muscle force the angle between the muscle's line of pull and the axis of the bone to be moved determines the angle at which the force is applied.



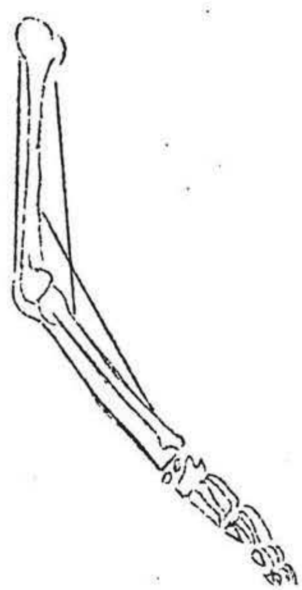
   a) This is not constant as when pulling an object, because the pull of the muscle results in rotation of the bone, which then changes the angle of pull.

   b) The more nearly the angle of pull approaches 90 degrees the more effective the contraction will be. This rarely occurs.

c) When the angle of the pull is less than 90 degrees only part of the force is effective in producing the desired movement.

d) Much of it acts as a stabilizing force, keeping the bone in the joint.

3. The greater the angle in relation to the horizontal plane the more the lift.
4. The greater the angle of force on the lever, the greater the rotation of the lever.
5. A vertically downward application of force increases friction.
6. The heavier the load the greater vertical angle needed (overcome friction).
7. Force should be applied in line with the center of gravity of the body to be moved.



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IX. MOMENTUM - (magnitude of force)

A. DEFINITION

The product of mass (weight) times velocity (speed) of an object.

B. IMPORTANCE

1. That quantity of motion which determines the time necessary to stop an object's movement.
2. That quantity of motion which determines the force necessary to obtain a desired result.

C. FACTORS

1. Force must be sufficient to overcome the inertia of the object if momentum is to result.
2. A heavier object moving slowly may have more momentum than a light one moving fast.
3. Momentum of a light object may be increased by moving it faster.
4. Force applied over a longer period of time will create more momentum.
5. Momentum of one object may be imparted to another.
6. Momentum of one part of an object may be transferred to another part of that object.
7. Momentum depends upon the speed at which an object is moving as well as the mass of the object being moved.

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X. ABSORBING FORCE

A. DEFINITION

Deceleration or stopping a moving object. Reducing momentum.

B. IMPORTANCE

1. Enables one to control own body momentum.
2. Able to stop other moving objects.
3. Makes possible smooth movement by continuity into recovery and next movement.

C. FACTORS

1. Force must be absorbed, or spent, gradually.
   a) The greater the momentum the longer time required to stop.
   b) The greater the momentum the more the distance required in which to apply resistance.
2. The force of impact depends upon the:
   a) The weight of an object.
   b) The speed at which it is moving.
3. Balance must be considered in any task involving force absorption.

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XI. AXES OF ROTATION - (fulcrum)

A. DEFINITION

Center around which parts turn.

B. IMPORTANCE

The axis is always a point of contact or support of objects attached.

C. TYPES OF AXES

1. Transverse (acrosswise).
2. Longitudinal (lenghthwise).

D. FACTORS

1. The axis is around a center of gravity or imaginary long line of a segment or total body in a freely moving object.
2. The type of axis determines ease and range of rotation.
3. In body movements action at various axes may occur simultaneously or in sequence.

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XII. LEVERS

A. DEFINITION

A simple machine for execution of work, a rigid bar turning about an axis.

B. IMPORTANCE

1. Lengthens the force arm to make force more effective.
2. Shortens the resistance arm to make the range greater.
3. The movement is rotatory.
4. There must be force to operate the lever and there is a resistance to overcome.
5. The levers in the human body are the bones, rotating about their particular attachments (axis) to the adjacent segment.
6. The force for operating the various levers within the body is produced by muscle contractions.
7. The resistance is the center of gravity of the body part plus any added weight.

C. TYPES OF LEVERS

1. First Class - the axis (fulcrum) is located between the resistance and the force.

   R A F

2. Second Class - the resistance is located between the axis and the point of application of force.

   F
   A R

3. Third Class - the force acts at a point between the axis and the resistance. The resistance arm always longer than the force arm.

   F
   A R

D. FACTORS

1. The effectiveness of a lever depends upon the location on the lever of the axis, the point at which the force is applied, and the point at which the resistance is applied.
2. Muscles in the body have two effects on the various levers since force is applied at an angle less than 90°:
   a) Rotatory effect necessary for movement.
   b) Stabilizing effect, important in relieving joint strain and in maintaining joint structure.
3. Lengthen the force arm to make force more effective.
4. Shorten the resistance arm to increase the range of movement.
5. First class lever favors balance.
6. Second class lever favor force.
7. Third class levers favor speed and range of movement.
8. The levers of the body are primarily of the third class. Most of the muscles attach close to the joints producing a short force arm. Since the segments are long the weight (resistance) is concentrated farther from the joint.
9. The human body does easily those tasks which involve fast movement with light objects.
10. When heavy work is demanded the human body must use some type of machine in order to gain a force advantage.
11. Sports instruments lengthen the levers of the body. Through their use the limitations of human force are compensated for by the greatly increased speed of the object imparting the force

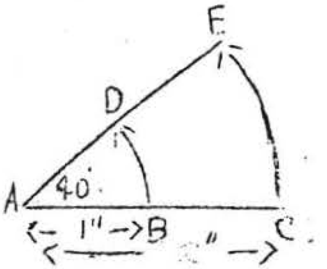
(because of the increased length of the lever).

*12. Leverage in the human body almost never involves a single body part (a simple lever). Movement results from a system of levers working together.

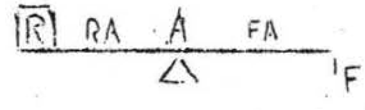
13. Even when movement of a simple lever does take place, many other parts of the body must be immobilized.

*14. When force is produced by the human system of levers is dependent upon speed at the extremity (throwing), the levers function in sequence, each coming into action at the time that the one before has reached its maximum speed.

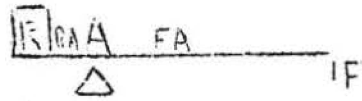
15. When many levers are brought into a heavy task (pushing) they function simultaneously.



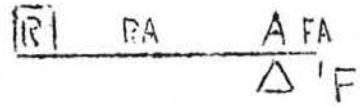
Lever AC - moves twice as far and twice as fast as lever AB (if the distance is covered in the same period of time)



favors equilibrium

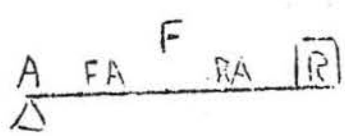


favors force



favors speed

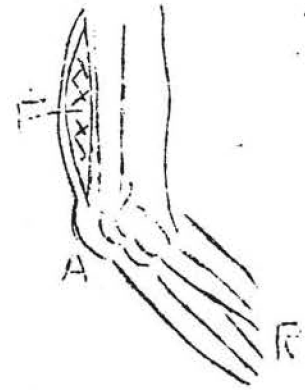
favors force

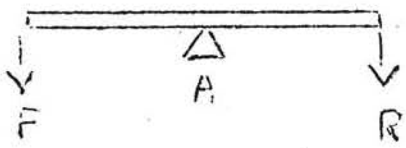


favors speed + range of movement

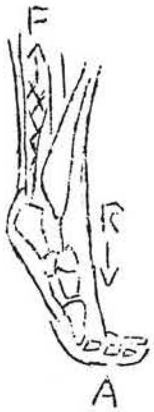
FA - force arm - (power arm)
RA - resistance arm
The two m[illegible] ...

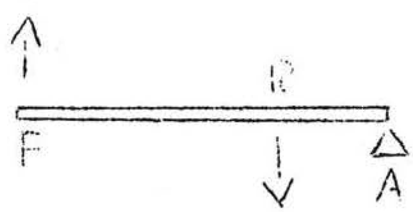
First-class



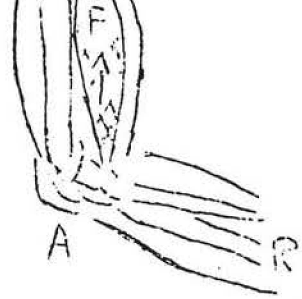


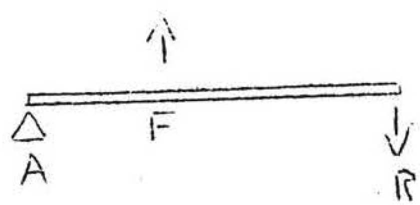
Second-class





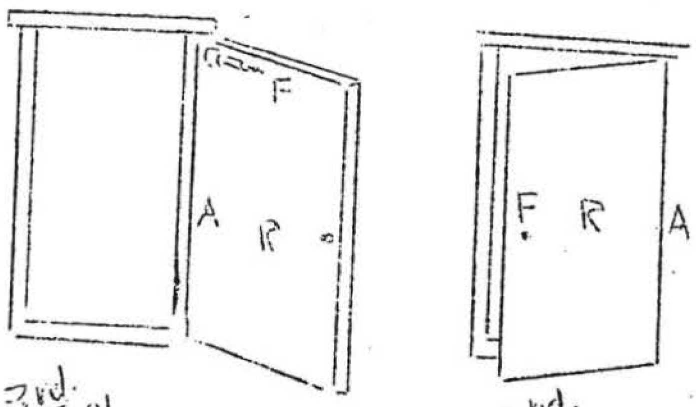
Third-class





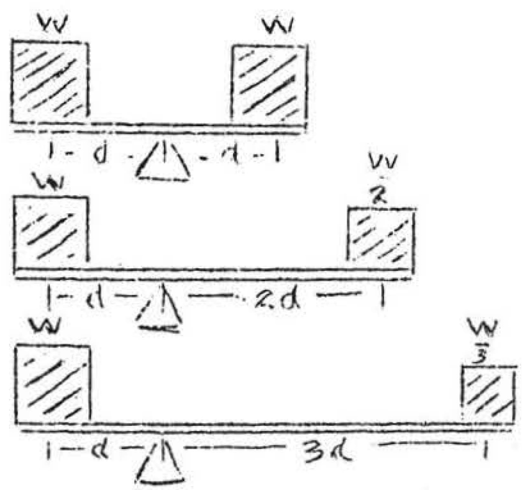
Closing a door

Opening a door



3rd. class

2nd. class



Lengthening the force arm - makes force more effective.

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XIII. MOMENT OF INERTIA IN ANGULAR MOTION

A. DEFINITION

Effectiveness of resistance to angular motion.

B. IMPORTANCE

1. Related to ease and speed of rotation.
2. Related to the amount of force necessary to produce rotation.

C. FACTORS

1. The more concentrated the mass around the axis, the less the amount of inertia.
2. The moment of inertia varies as the part flexes or extends.
3. The greater the distance the force is applied from the axis the greater is the effect in producing rotation about the axis.

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XIV. AIR RESISTANCE

A. DEFINITION

Resistance of the air wall to an object pressing through it.

B. IMPORTANCE

1. Is present in all normal activities of the human body.
2. In some activities it is so small a factor it need not be considered. In other activities it is an important factor.
3. Is a factor in overcoming moving inertia.

C. FACTORS

1. Increases as speed increases.
2. Is constant except for alterations from air currents.
3. Is so slight that effects are significant only at high speeds.
4. The surface, size, shape, and weight of an object help determine the air flow around it.
5. A light object with a large surface falls more slowly than a small compact object.
6. If the object has linear motion the air resistance is constant all over the surface presented to the air wall.
7. If the object is rotating the side which is turning into the air wall meets increased resistance.

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XV. SPIN

A. DEFINITION

Ball is turning around a vertical or horizontal axis through its center.

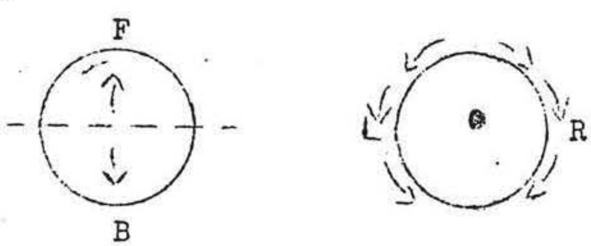
Rotation, top spin, back spin, or side spin.

B. IMPORTANCE

1. Spin can raise or lower the line of flight.
2. Spin can increase or decrease length of flight or distance of roll.
3. Spin can alter the angle of rebound and the speed of rebound.
4. Spin can cause the path of the ball to curve laterally.

C. FACTORS

1. Spin may occur around a horizontal or around a vertical axis.



2. Spin is discussed in terms of right or left around a vertical axis; forward or backward around a horizontal axis.
3. A ball must be hit so that the contacting surface of the ball is moved while in contact.
4. A rough ball will acquire spin more readily than a smooth one (because of friction).
5. Spin is produced by the difference in air resistance on the two sides of the ball:

a) Pressure is built up on one side, where air resistance to forward motion is in opposition to that of the aid moving around the ball.

b) A low pressure area results on the opposite side of the ball where the two forces are in the same direction and the velocity of the moving air is increased.

c) The ball tends to move toward the side where the pressure is least. If the ball is spinning to the right around a vertical axis, the pressure is on the left, thus causing the ball to curve to the right.

6. In a fast moving ball the spin effect occurs late in the flight.

7. Spin has more effect on the direction of a light ball than a heavy ball because the heavy ball has a greater momentum which makes it less responsive to aid pressure.

8. Spin affects the roll of a ball when it lands.

9. Spin is caused by an off center application of force.

10. If the free motion of an object is interfered with by friction or the presence of some obstacle, rotatory motion results in spite of the fact that the force is imparted through the center of gravity (because of friction between ball and ground.)

11. Spin increases the difficulty of acquiring accuracy in hitting a desired target.

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XVI. REBOUND

A. DEFINITION

An object which meets resistance is acted upon by a counterforce, or will rebound.

B. IMPORTANCE

1. Ability to anticipate bounce or reaction of an object.
2. Determines where a ball will go and how it should be played.
3. Can direct a ball where it could not otherwise be thrown.
4. May be used as an asset or it may result in an error in placement.
5. Striking surface may be altered to direct the ball.

C. FACTORS

1. Rebound is modified by the firmness of the striking surface of the ball and the speed of the ball.
2. Rebound is modified by the firmness of the surface the object strikes.
3. Round surfaces offer various faces.
4. The angle of the rebound equals the angle at which contact is made unless modified by spin or lack of firmness of the striking object and the object struck.
5. The reaction of the object hit is just as great on the striking surface as the force which projects it into space. The striking surface should be of firm substance and it should not "give" when contacting the object.

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I. GRAVITY

1. Which of the following is not true concerning the pull of gravity(on earth)?
   a. It is always present.
   b. Affects all objects.
   c. Is horizontal.
2. One of the following is not true concerning the pull of gravity.
   a. The weight and size of an object has no effect upon the rate of fall.
   b. Gravity may be overcome.
   c. Gravity may be matched.
3. Which of the following is true concerning the pull of gravity upon the human body?
   a. A heavy body experiences less gravity pull.
   b. A well aligned body experiences less gravity pull.
   c. It makes no difference how the body is aligned, the gravity pull is the same.

II. CENTER OF GRAVITY

1. Which of the statements is <u>not</u> true?

    a. The center of gravity may be outside the body in certain movements.

    b. The center of gravity is in the region of the hips in the standing position.

    c. The center of gravity is at the point of intersection of weight lines of the body planes.

    d. The center of gravity of the body is the same for any movement.

2. The center of gravity in the body is:

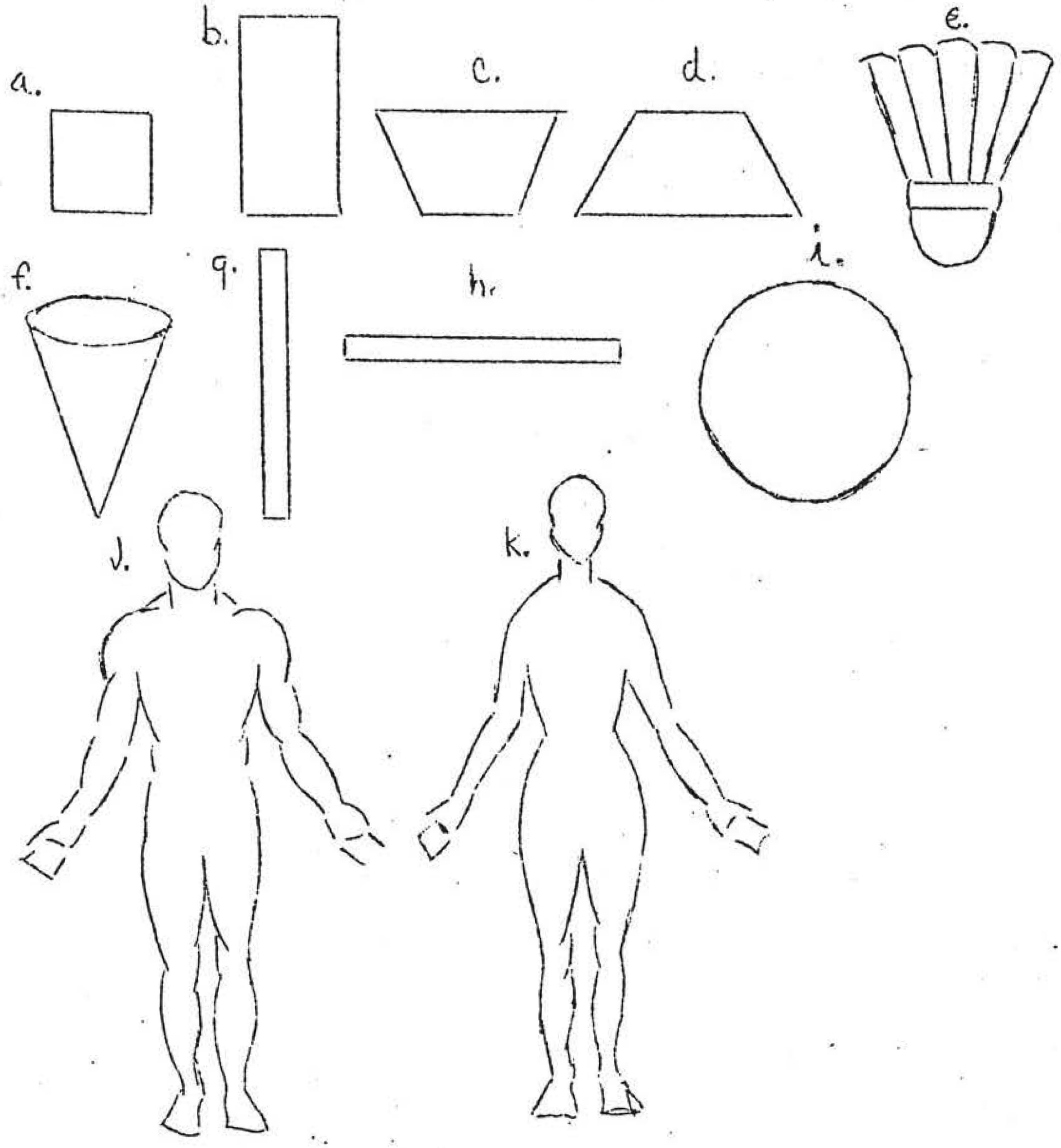
    a. The geometrical center of the body.

    b. Easily determined.

    c. Lower in the body of the male than the female.

    d. None of the above.

3. Mark the center of gravity in each of the following objects.



III. BALANCE

1. In the standing position the body is most easily balanced when:

   a. Feet are very close together. b. Feet are in a wide stride position.

   c. Feet are a few inches apart.

2. The most important aspects in balance are:

   a. The size of the base. b. The height of the object.

   c. Weight of the object. d. Center of gravity of object.

   e. Shape of the object. f. a and b

   g. a and d h. b and c

3. Which of the body positions is the most stable when being pushed from a forward direction?

   a. Feet a few inches apart. b. Wide side stride position with knees flexed.

   c. Forward position with knees flexed. d. Wide forward stride position.

4. Which of the following objects is the <u>most</u> difficult to balance?

   a.  b.  c.  d. 

5. Which of the body types is the most stable?

   a. Tall and thin. b. Short and muscular. c. Short and fat.

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IV. MOTION

1. Newton's first law of motion concerns:

   a. Acceleration b. Counterforce. c. Inertia.

2. Inertia is the existing state of:

   a. Rest. b. Motion. c. a and b.

3. Which of the following is the best example of linear motion?

   a. Riding downhill on a sled. b. Walking in a straight line.

   c. The flight of a thrown ball. d. Executing a golf swing.

4. Force applied to an object through its center of gravity will cause it to move:

   a. In an angular path. b. In a straight line. c. In a spinning fashion.

5. Motion involves:

   a. Inertia. b. Rotation. c. Acceleration. d. Counterforce.

   e. All of the above. f. c and d.

V. FRICTION

Which of the following situations creates the greatest amount of friction?

a. A large, heavy object being pushed.

b. A large, light object being pulled.

c. A heavy object being pulled.

d. A large, light object being pushed.

VI. FORCE

1. In the human body force is supplied primarily by the:

   a. Muscles. b. Bones. c. Nerves.

2. Muscles exert force by:

   a. Stretching. b. Pulling. c. Pushing. d. Shortening.

   e. a and c f. b and d

3. Muscles work more efficiently when they begin on a:

   a. Stretch. b. Pull. c. Push.

4. Force as it applies to work must take into consideration which of the following?

   a. Magnitude. b. Duration. c. Direction of application.

   d. Point of application. e. All of these. f. Two of the above.

5. Force is:

   a. Friction between feet and ground.

   b. The process of changing position or place.

   c. Center of a body mass.

   d. A state of stability.

   e. Strength or power exerted upon an object.

   f. a and e

   g. b and c

VII. CENTRIFUGAL FORCE

1. Centrifugal force is:

   a. Tangential force. b. Strength or power exerted upon an object.

   c. Motion. d. a and b. e. a and c.

2. Centrifugal force is increased by:

   a. Fast rotary action. b. Fast linear action.

   c. Motion in a straight line. d. Motion in an angular direction.

3. Accuracy involving the use of centrifugal force includes primarily:

   a. Speed. b. Force. c. Timing of circular motion.

   d. Timing of release.

VIII. PARALLELOGRAM OF FORCE

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1. A diagonal application of force results in which of the following forces?

   a. Upward. b. Forward. c. Friction. d. All of these.

   e. a and b.

2. Muscle pull (force produced by muscles) differs from any other pulling force due to:

   a. Ability to stabilize the complete pulling force. b. Rotation of levers.

   c. Intensity of force available for desired task. d. Great angle of force on the lever. e. Changing angle of pull.

3. Linear motion takes place most efficiently when an object is thrown, if:

   a. Force is applied at an angle. b. Force is applied through the object's center of gravity. c. Force is applied above the object's center of gravity.

IX. MOMENTUM

1. Which of the following best describe momentum:

   a. Strength or power exerted upon an object. b. Constant force.

   c. The process of moving or changing position. d. The product of an objects weight times its speed of movement. e. The speed an object is moving.

2. Which of the following statements is true?

   a. A light object moving slowly may have more momentum than a heavy object moving slowly.

   b. A light object moving fast may have more momentum than a heavy object moving slowly.

   c. Momentum may be transferred from one object to another but may not be transferred from one part to another part of that same object.

   d. None of the above. e. a, b, and c.

3. An increased backswing increases the momentum of a throw due to:

   a. The magnitude of the force. b. A decrease in resistive force.

   c. The increase in duration of the application of force.

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X. ABSORBING FORCE

1. Which of the following factors is (are) of major importance when absorbing force?

   a. Speed object is traveling. b. Time necessary to stop object.

   c. Distance necessary to stop object. d. Weight of object.

   e. All of these. f. b and c.

XI. AXES OF ROTATION

1. The human body is constructed in such a way that one of the following types of axes is most economical and effective.

   a. Transverse. b. Longitudinal. c. Lengthwise. d. Vertical.

2. An axis can be around the:

   a. Line of gravity of a segment. b. Line of gravity of the total body.

   c. Center of gravity of an object. d. All of these. e. a and c.

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XII. LEVERS

1. Force is the mid-point in which of the following types of levers?

   a. First class. b. Second class c. Third class.

2. Levers of the human body are almost entirely of the:

   a. First class. b. Second class. c. Third class.

3. Which of the following types of levers favors speed and range of movement?

   a. Third class. b. First class. c. Second class.

4. Which of the following types of levers favors balance?

   a. Second class. b. Third class. c. First class.

5. An example of a third class lever in the body is:

   a. Foot raised to a position with weight on ball of foot.

   b. Forearm, extended by triceps. c. Forearm, flexed by the biceps.

   d. Flexion and extension of the foot, with no weight on it.

6. When executing an underhand throw, the straight arm, pendulum swing is an example of which type of lever?

   a. Second-class. b. Third-class. c. First-class

   d. More than one type.

XIII. MOMENT OF INERTIA IN ANGULAR MOTION

1. A large ball compared to a small ball will:

a. Take more power to move it   b. Take less power to move it.

c. Have less momentum.

2. A long lever as compared to a short lever will have:

a. Less force.   b. Less speed.   c. Greater speed.

XIV. AIR RESISTANCE

1. Which of the following factors influence the effect of air resistance on an object.

a. Shape.   b. Size.   c. Weight   d. Momentum.   e. All of these

f. a, b, and c.

2. Air resistance has the greatest effect upon the flight of which of the following objects?

a. Small compact object moving fast.   b. Large, light object moving fast.

c. Large, light object, moving slowly.

XV. SPIN

1. Which of the following types of spin will affect the speed of a rolling ball?

   a. Right. b. Back. c. Left.

2. A ball spinning to the left:

   a. Is turning about a horizontal axis. b. Has a greater pressure on its left side. c. Has a greater pressure on its right side.

XVI. REBOUND

1. Which of the following is the major determinent of a solid ball rebounding at a different angle form the one with which it approached a stationary object?

   a. Spin on striking object. b. Momentum of striking object.

   c. Elasticity of striking object. d. "Give" of object struck.

2. The force of the rebound of a solid ball from a solid, stationary object depends upon:

   a. The speed of the ball. b. The inertia of the stationary object.

   c. Weight of stationary object. d. Weight of the striking object.

   e. All of these. f. c and d.

3. Which of the following has the least effect on a rolling ball rebounding from a stationary object?

   a. Momentum. b. Counterforce. c. Spin. d. Gravity.

   e. Inertia.

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The sources of reference used in the development of the following material are:

Marion R. Broer, Efficiency of Human Movement. 2d ed., Philadelphia: W. B. Saunders Co., 1966.

M. Gladys Scott, Analysis of Human Motion. 2d ed. New York: Appleton-Century Crafts, 1963.

MOTOR PATTERNS

I. STANDING

A. Standing is not static, it is a process of balancing on a stationary base. There is a constant sway of the body in the positions we refer to as static. Attempts to eliminate this sway result in discomfort and often a feeling of faintness. This sway is important in the return of venous blood to the heart.

B. The correct standing position requires the balancing of body segments above each other which minimizes:

1. Friction and uneven pressure in weight bearing joints.
2. Strain on muscles and ligaments.

C. Acute stress can result from chronic (or repeated) small stresses.

D. Efficient posture is that in which:

1. The center of gravity of each body segment is centered over the segment immediately below it.
2. The body is able to utilize the force of gravity to maintain alignment in the weight bearing joint.
3. The center of gravity of the body is centered over its base.

4. Stability is maintained with a minimum of strain.

E. Balance must be maintained in both the anteroposterior (forward-backward) plane and the lateral (sideward) planes.

F. Balanced standing posture:

1. The feet -
   a) A few inches apart.
   b) Toes pointed straight ahead.
   c) Weight on heels and outer borders of the feet.
2. The knees -
   a) Should not be hyperextended.
   b) Most efficient and the safest position is with the knees slightly bent ("easy" position).
3. The pelvis -
   a) Held in a balanced position, centered directly above the legs.
   b) The control of this segment of the body is extremely important to the ability to assume and maintain total body alignment.
4. Shoulder girdle -
   a) Should be balanced above the hips.
   b. Shoulders should be level.
   c. Shoulders should be pointing directly sideward.
5. Head -
   a) Should be carried in a level position.
   b) Top of head should be up.

G. Balanced posture contributes to:

1. Increased endurance (delays fatigue).

2. The ability to move quickly.

3. The decreased incidence of strain or injury to muscles, joints, ligaments, and/or tendons.

4. A better appearance in all clothes.

II. BALANCING WEIGHT ON ONE FOOT -

A. Balancing the body weight on one foot occurs in every walking step but it is for such a brief period it causes no difficulty, except when we are first learning to walk. Also weight is balanced on one foot during the performance of certain stunts, dance routines, and during the performance of various sport skills (kicking, sliding, and throwing).

B. The problem is that the same body weight must be centered over a smaller base.

C. When standing upright the anteroposterior balance is the same as when on both feet.

D. But, the lateral balance becomes a problem.

E. Raising the arms and shifting the trunk are common adjustments.

F. When these adjustments do not maintain balance the supporting foot begins to invert or evert, depending upon the weight shift.

G. If this does not maintain balance, then movement of the supporting foot acts as a counteraction.

H. If the body weight shifts completely outside the base of support, a hop often helps re-establish a base of support.

I. If this fails, the other foot must be placed on the ground in order to form a larger base.

J. If the trunk and arms are extended forward one leg must be extended backward, if balance is to be maintained.

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III. WALKING -

A. The general body position in walking is the same as it is in standing—a well aligned position.

B. Walking is a process of disturbing the balance of the body. A process in which the center of gravity is continually shifting.

C. In order to walk, inertia must be overcome by:

1. Force of the pushing foot.

2. Downward pull of gravity as the body is pushed forward.

D. The lateral distance between the feet becomes important. Why?

E. The arm swing should be in opposition to the swing of the legs in order to:

1. Reduce trunk rotation.

2. Add to the momentum of the force of the movement.

F. There is a short period of double support in every step when walking forward.

G. When the foot strikes the ground after the swinging phase of the walk, there is a backward counterpressure of the ground against the foot which checks the forward momentum of the body,

H. A slightly forward incline of the body (center of gravity of the body inclined forward) makes it possible to apply more force in the direction of the movement (walking forward). This incline should be from the ankles if the center of gravity is to be shifted.

I. The speed of the walk is determined by:

1. The magnitude of the pushing force, which in turn, depends upon:

a) Force exerted by the foot.

b) Resistance of the ground.

2. The direction of the application of force.

J. Friction is necessary if the counterforce is to be transferred to the body.

1. The more vertical the force application the more effective the friction.

2. The less friction the less the power.

3. Shortening the steps keeps the center of gravity vertically above the base. This increases or decreases friction?

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IV. HOLDING AND CARRYING

A. When an object is held it becomes part of the total body weight and the center of gravity of the body shifts in the direction of the added weight.

B. If balance is to be maintained the new center of gravity must be shifted back over the supporting base.

C. The nearer the weight is held to the body's center of gravity the smaller the rotary force exerted upon the body.

D. Weights which are held above or below the center of gravity of the body must be compensated for by excessive leaning. This leaning usually involves strain upon the lower spine and the lower back muscles.

E. A weight held only on one side of the body requires support by the trunk muscles of the opposite side as well as from the arm and shoulder muscles on the carrying side.

F. A weight should be held as close as possible to the body. Why? (Concerns levers).

V. UNDERHAND THROWING PATTERN

A. The faster the hand is moving when the ball is released the faster it will move.

B. Increasing the backswing in preparation for the throw increases the duration of the application of force.

C. The more body parts that contribute to a particular movement the greater the speed (and force) of the movement.

D. The shifting of the body weight forward (from the ankles, why?) with the throw forces more body parts into action.

E. Bending the knee of the forward leg decreases resistance to forward momentum. This bending of the knee also flattens the arc of the throw.

F. When rolling a ball, in order to place the ball on the ground, it is necessary to lower the body so that the principles of the parellelogram of force may be applied most efficiently.

G. The bending of the knees, the forward lean and the weight of the ball as it swings through may be compensated for by using the free hand and arm as counter balancing force.

H. Throwing while moving requires a great deal of balance. According to what you have already learned should the steps be big or little?

I. The moment of release should be at the moment of maximum momentum if the object is to receive maximum speed.

J. The follow through (continuing of the arc which is formed by the pendulum arm swing) allows for the maximum momentum to be transferred to the ball.

K. When rolling a ball the vertical plane should not be involved, however, friction does become an important factor(after the release).

L. In an underhand throw the arm and hand are moving in an arc, which means the principles of centrifugal force must be considered. How can we apply the knowledge of these principles to this particular situation?

M. The flatter the arc in which the hand is moving the greater the potential for accuracy.

N. The distance a thrown object will travel depends upon:

1. The force imparted to the object at release.
2. The angle at which the object is released.
3. The counter action of outside force.

O. Does top spin and back spin affect the direction a rolling ball travels? Does right or left spin affect the direction a rolling ball travels?

P. Analysis of the underhand throw:

1. The object must be pushed away from the body as an initial preparation for the throw.
2. The object is now in a position in which gravity can aid in the dropping and backward movement.
3. As the object reaches the height of the backswing gravity again assists in the swing-through (forward swing), since the arm swing is in a vertical plane.
4. When the object is released it has gained forward momentum through the assistance of the pull of gravity.

Q. This pattern of throwing is not the most effective one when maximum power or distance is required.

R. The underhand throw is the most effective pattern when control and accuracy are required.

S. As force is increased maintaining balance becomes more of a problem.

T. The greater the distance the ball must travel before reaching the target the more important are control and accuracy at release.

This increased distance the ball must travel allows more time for other forces to act upon it before it reaches the target.

What are the main forces that would act upon a rolling ball in this situation?

VI. STRIKING

A. In executing striking skills force must be produced and then applied to the object to be struck (either directly or indirectly) in a manner that will achieve the desired results.

B. What is Newton's Third Law of Motion? How would it apply to the pattern of striking?

C. The surface applying the striking motion must be firm if maximum force is to be transferred to the object struck.

D. Discounting other forces which may act upon an object, the speed of an object being struck depends upon:

1. Resistance
2. Weight, and
3. Speed

of both the object being struck and the object doing the striking.

E. The methods used to increase force in a striking pattern of motion are the same as those used to increase force in a throwing pattern:

1. Increase the backswing.
2. Involve as many body parts in the movement as possible. (How would this be accomplished?)
3. Coordination of all body movements.
4. Projection of the object at the moment of maximum momentum.
5. Prevent any resistive force. (How is this accomplished?)

F. Factors which influence the amount of force which is applicable to striking:

1. Firmness of the surface of the striking implement.

2. Weight of the striking instrument.

3. Length of the striking implement. (Why would this increase force?)

4. Firmness of the surface of the object struck.

5. Applying the striking force through the center of gravity of the object being struck. (How would this increase force?)

G. When a moving object strikes a firm, stationary object the primary force to be considered (or contended with) is that of the striking object. (Why?)

H. The angle of rebound depends primarily upon the angle at which the striking implement contacts the stationary object. What are some other factors which would influence the direction of the rebound?

I. The factors which influence the distance a rebounding object will travel are the same as those which determine the distance a thrown object will travel:

1. Momentum of the striking object.

2. Angle of impact.

3. Counter force.

TEACHING UNIT -- MOVEMENT PRINCIPLES

I. GRAVITY --

Demonstrate --

A. Drop a light ball and a heavy ball.

B. Discuss the difference in the speed of fall of the two objects.

C. Explain and remind students of the pull of gravity on all body segments, briefly. This material will be covered later in greater detail.

C. Ask for questions from the group.

II. CENTER OF GRAVITY --

Explain and demonstrate the center of gravity of:

A. A symmetrical object.

B. An irregular object.

C. The human body:

1. Male

2. Female

3. Unusual body positions (center of gravity outside the body):

a) Kicking.

b) Long throw.

III. BALANCE --

A. The larger the base the more stable the object.

Experimentation:

1. Standing on one foot.

2. Standing on two feet, with the feet as far apart as possible.

3. Feet a few inches apart(normal standing position).

B. Base enlarged in the direction of the opposing force.

Experimentation:

1. Pushing against the body, different positions and different directions.

2. Explain about not restricting movement of joints, allowing for some "give" at joints.

   a) Ways of allowing for some give.

C. Center of gravity above the supporting base.

Experimentation:

1. Assume normal standing position, lean forward from the ankles, moving the line of gravity toward the outer rim of the supporting base, continue leaning forward until the line is outside the rim.

   a) How will you know when this has occurred?

   b) Would you agree that there is a limit to how far the line of gravity may be shifted, without adjusting the supporting base?

2. Assume other standing positions, involving this principle:

   a) Bending forward with the weight on one foot.

   b) Bending backward with the weight on one foot.

   c) Discuss the adjustments that must be made in order to maintain balance.

D. The lower the center of gravity, the more stable the object.

Demonstrate and Explain:

1. A tennis racquet (standing on end) and a tennis racquet (standing on its side).

2. Pole and a standard.

E. Balance in the human body is a process in which the muscles are attempting to control the center of gravity in relation to the supporting base. With each movement, body adjustments are necessary if balance is to be maintained.

Experimentation:

1. Walking
2. Running
3. Throwing
4. Carrying
5. Holding an object at arms length.
6. Weight up on the balls of the feet.

IV. MOTION --

A. Newton's Laws of Motion:

1. Law of Inertia -

Resistance to motion or change of motion.

Demonstrate:

a) A ball - still.
   (1) Heavy
   (2) Light
b) A ball - rolling.
   (1) Heavy
   (2) Light
c) A ball placed on a slanting board.
   (1) Heavy
   (2) Light

2. Law of Acceleration -

Acceleration is directly proportional to the force producing it; acceleration is also proportional to the mass of the body being moved; acceleration is in the same direction as the force producing it.

Demonstrate:

a) Rolling ball.
   (1) Fast and slow.
   (2) A light and a heavy ball.

3. Law of Counterforce -

Every force which meets resistance has an equal and opposite counterforce.

Demonstrate:

a) Bounce a ball.

b) A rolling ball striking an object.

(1) Still object.
(2) Moving object.

B. Types of Motion -

1. Translatory - (linear) -

An object moving as a whole in the direction of the motion. All points move in a straight line and at an equal distance.

Demonstrate: Sliding a disc across the floor.

2. Rotatory - (angular) -

One point serves as a center about which all other parts move at a rate and distance directly related to their distance from that axis.

Demonstrate:

a) Walking.

b) Rolling a ball in a straight line. Is this linear or rotary motion?

C. Application of force through an object's center of gravity - which results in the object moving in a straight line (linear path).

Demonstrate:

D. Application of force away from the center of gravity - producing an angular path of the moving object.

Demonstrate:

E. Make a point of explaining the use of the terms:

1. Linear
2. Translatory
3. Rotatory
4. Angular
5. Rotary

F. Question -

1. What are the factors which modify motion?

a) Friction
b) Air resistance
d) Water resistance
e) Gravity

V. FRICTION --

A. Question -

What is friction?

Resistance between two surfaces where one is sliding or rolling on the other.

B. Sliding an object:

Demonstrate:

1. Heavy object.
2. Light object.

C. Pushing an object:

Demonstrate:

1. A big heavy object.
2. A big light object.

D. Experimentation:

1. Have students push an object in stocking feet and with tennis shoes on.
2. Discuss the differences and why.
3. Angle of application of force.

a) From above (increasing friction).
b) Pushing an object with attention given to:

(1) Friction between object and the floor.

(2) Friction necessary between the feet and the floor.

c) Pulling an object (decreases friction).

E. Ask for questions from the group.

VI. FORCE --

A. Force in the human body is supplied by the muscles,which are brought into action by the nerves.

Muscles contract to exert force, therefore, they shorten in order to exert a pulling force.

B. The amount of force necessary for a given task determines the number of muscle fibers within a muscle and the number of muscles which will be called upon for action. Much of this is determined by certain processes within the nervous system. But, conscious thought can certainly add to efficiency and decrease strain.

Example:

Picking up an object that is heavier than you thought it was going to be.

C. To supply maximum force all body parts that can contribute to the movement must be used to their maximum, however, maximum force is seldom required of the human body.

Quite obviously,strong muscles can exert more force than weak ones.

It is important to know which are the strongest muscles of the body and how to use them in order to avoid strain and undue fatigue.

In which part or parts of your body do you have the most strength?

Experimentation: (using the underhand throw to roll a ball)

1. Feet together and no backswing (natural position of feet).

2. Feet together (natural position) and a <u>big</u> backswing.
   What happened? (more force but off balance).
3. Feet together, big backswing, and take one step as the ball is swung through (explain about R or L foot, whether R or L handed).
4. Feet in a forward stride position, big backswing, and take one step as the ball is swung through.
5. Was there any difference in the two throws? What was it?
6. Start with feet together, big backswing as several steps are added.
7. Set the number of steps(4), big backswing, and roll the ball as hard as possible.
   What adjustments did you make in order to get added strength?
8. Repeat, paying particular attention to the position of the body after the ball has left the hand.
9. Discuss ways of stopping forward motion of the body after the release of the ball. (a slide or a few steps after the release of the ball).
10. Repeat, allowing a slide or a few steps after the release. Why?

D. Force is not effective or efficient when moving an object unless there is a firm base (friction between feet and ground).

E. The point at which force is applied will determine the path of movement. Remember, we discussed this earlier.

<u>Demonstrate:</u>

1. Application of force through the center of gravity of the object - moving a piano - in a straight line.
2. Application of force to the side of the center of gravity of the object - moving a piano - in a circle.
3. Bring out the point that if linear motion is desired, then it takes

more effort, if force is applied at any point other than that which is in line with the center of gravity of the object.

4. And the reverse is true also, if rotary action is desired, it is much more difficult to obtain this when force is applied through the center of gravity of the object.

F. Preparation for the application of force. "Set" position. You would not run up to a heavy object to be moved with any real thought of moving it.

VII. CENTRIFUGAL FORCE --

Demonstrate

A. With a string and a weight tied on the end of it--releasing the string at several different points along (or on) the arc.

B. Discuss what happens to the object when it is released at a different point upon the arc.

C. What is the most important consideration when accuracy in hitting a target is important? (timing or moment of release)

VIII. PARALLELOGRAM OF FORCE --

A. Pulling an object with a rope:

Demonstrate:

1. The two forces which result are? (Up and forward)

2. The heavier the object being pulled the more desirable the upward force. Why? (overcome friction).

3. How important is friction in pulling an object?

a) Between object and floor.

b) Between feet and floor.

c) Advantage when rollers are used on heavy objects.

B. Pushing an object:

Demonstrate:

1. The object is low (force downward and forward)

2. The object is high (force is primarily forward).

   What would be the determining factor as to wether the force is forward or not?

3. Again, discuss the importance of friction. (a,b, and c)

C. In the human body,the angle between the muscle's line of pull and the axis of the bone to be moved, determines the angle at which the force is applied. We have no conscious control over this, other than using the parts of the body best suited for the job.

D. Muscle pull within the body is <u>not</u> constant as it is when pulling an object. Because of the attachment of muscle to bone and the general construction of the body. When one segment of the body is being used it is virtually impossible to completely stabalize the rest of the body, because of the flexibility, the give, and the stretch of the body.

The pull of the muscle results in the rotation of the bone, which then changes the angle of pull.

E. When the angle of pull is less than 90^{o} only part of the force available is applicable to the desired task or movement.

F. A great deal of available force is used in an effort to stabalize the bone in the joint, thus preventing injury.

G. Within the human body - a 90^{o} angle of pull rarely occurs -- therefore- within the human body maximum force <u>can not</u> be applied to a specific movement, part of the force must be used for other purposes, which in turn makes the desired movement possible (at all), in the human body.

Ask for questions from the group concerning C,D,E,F, and G.

H. The greater the angle of force on the lever, the greater will be the rotation of the lever.

Explain and draw a diagram on the board, also refer them to the diagram on page 11 of the principles. Use the bicepts flexing the fore-arm.

I. Force should be applied in line with the center of gravity of the body to be moved, if linear motion is desired.

Demonstrate, briefly: (this has been done before but not in relation to pushing or pulling)

1. Pulling an object, applying force through the center of gravity.
2. Pushing, striking, or throwing an object, this same principle would apply if linear motion is desired.

IX. MOMENTUM --

A. You already know that force must be sufficient to overcome the inertia of an object if it (the object) is to be moved.

Demonstrate:

1. Pushing - a heavy object, the parallel bars with the brake on, not enough force to over come inertia.
2. Picking up a moderately heavy object, using back and leg muscles, a heavy dumbbell.

You should have also learned that the greater the objects mass or any resistive forces, such as friction, the greater the inertia of the object and consequently consequently a greater amount of force is necessary to move the object.

B. Remember, the amount of force produced depends upon the magnitude of the propelling force and it's duration. In this case what is the propelling force? What is the resistive force? The duration of force?

C. Pull from the group, the idea that a heavy object moving slowly may have more momentum than a light one moving fast, help them think through this by means of the following experimentation.

Experimentation:

1. Have the students roll a light ball and a heavy ball using the the same amount of force.
   a) Weight on both feet with a very short backswing.
2. Question them about the results:
   a) Which had the most forceful impact of the two balls?
   b) Which one moved the fastest?
   c) Why?

D. In order to increase the momentum of the lighter ball what must we do? What adjustments must be made in order that the body may impart more force?

Experimentation: (using the light ball)

1. Allow several preparatory steps with a full arm, pendulum swing.
2. Question them about the results:
   a) Difference in body movement?
   b) Difference in momentum of the ball?

E. Discuss the idea that momentum of one object may be transmitted to another object or that momentum of one part of an object may be transferred to another part of that object (since the ball has now become a part of the body).

Experimentation:

1. Roll both the light and the heavy ball using several preparatory steps and a full backswing.

2. Set a number of steps and instruct them about starting either L or R, so that they may maintain balance and control.

3. Discuss the differences in impact of both these objects and what they did to cause it(the difference).

4. Roll both balls as hard as possible using total force available.

5. Discuss the difference in impact of the light ball in relation to the previous throw and the difference in impact of the heavy ball in relation to the previous throw.

6. Guide them to the conclusion that momentum of an object depends upon the speed at which an object is moving as well as the mass of the object being moved.

7. Ask for questions from the group and bring out any further information the group appears to need according to personal observations.

X. ABSORBING FORCE --

A. Force must be absorbed, or spent, gradually in order to prevent injury.

Experimentation:

1. Running and stop immediately.
2. Catching stiff armed. ------------ } > Easy! Gently!
3. Jumping and landing stiff legged. --
4. Underhand throwing --
   a) Starting position, 4 steps and big backswing, slight incline of the body - bend down and slide on the 4th step - continue the arm in the original arc (followthrough).
   b) Questions:

(1) What purpose does the slide serve?

(2) Why is the forward leg bent?

(3) Why should the arc of the arm swing be continued?

B. The speed at which the object is traveling will determine the amount of <u>time</u> and the <u>distance</u> necessary to stop the object.

C. The force at impact will depend upon the <u>weight</u> and <u>speed</u> of the object.

<u>Examples</u>:

1. Bullet fired from a rifle.

2. Batted softball.

3. Tennis ball, thrown.

4. Which would you prefer to attempt to catch?

D. The importance of balance in absorbing or spending force:

<u>Experimentation:</u>

1. Catching an underhand toss, by reaching way out to one side.

2. Catching an underhand toss, by moving the body directly in line with the oncoming object.

3. Enlarge the supporting base.

   In which direction should the adjustments be made? Why?

4. When executing the underhand throw, discuss the position of the free hand and arm!

   a) Should it be down at the side of the body?

   b) Should it be up and back during the throw?

   c) Why?

XI. AXES of ROTATION -- (fulcrum)

Simply as a review --

A. The two types of axes are:

1. Transverse or crosswise -

Who can give me an example of a movement involving a transverse axis?

a) Flexion of finger, knee or elbow.

b) Bending at the hips.

2. Longitudinal or lengthwise -

What are some examples of a movement involving a longitudinal axis?

a) Rotation of the palm of the hand in toward the body (pronation) and rotation of the palm of the hand out away from the body (supination).

b) Pronation and supination of hip and knee.

c) Frog kick in the elementary back stroke or whip kick in the breast stroke (swimming skills).

d) Walking with the toes turned in or out.

B. The axis is:

1. Around the center of gravity of an object (which we have already discussed).

2. Around the line of gravity of a segment or total body in a free moving object.

Examples:

a) Line of gravity of a segment, of the human body - elbow, knee, or hip.

b) Line of gravity of the total body - at particular points on the vertebral column (at points where rotation is possible) - waist, head, and the neck.

C. The main point to remember is that -- the type of axis determines the ease and range of rotation.

Of the two types of axes, which do we as human beings utilize most frequently and effectively? (transverse or crosswise)

D. In the process of body movement, action may occur in several of the axes at the same time or the action of the axes may occur in sequence. Rarely ever, does human movement involve just one axis. Because of the lack of force available in each of the segments.and of course due to the way the body is constructed.

XII. LEVERS --

A. What are the two forces necessary to operate a lever?

1. Force to operate the lever.

2. Force to be overcome (resistance).

B. What type of movement results?

(Rotary)

C. Which creates a greater rotation of force?

1. Increased force arm?

2. Increased resistance arm?

D. What is it that determines the class of the lever?

1. Depends upon which of the three points is in the mid-position.

a) Axis (fulcrum).

b) Point of force application.

c) Point of resistance .

E. In a first-class lever which of the three points is in the mid-position? (Axis)

Demonstrate:

1. Teeter board.

2. Crowbar.

3. Pair of scissors.

4. In the body -

   a) The forearm - extended by the triceps.

   b) The foot - no weight on it - flexion and extension by movement at the ankle.

   c) The head - pulled forward or backward depending upon the action of the anterior or posterior muscles (force). The antagonistic muscles and the inertia of the head are the resistance. The neck is the axis.

   d) Lower spine - (axis) intervertebral articulation - (force) either from abdominals or back extensors - (resistance) antagonistic muscles and weight of the trunk.

F. Which is the mid-point in a second-class lever? (Resistance)

Demonstrate:

1. Wheelbarrow.

2. In the body -

   a) Action of the foot - weight lifted from it's normal position (heel down) to a position on the ball of the foot. Axis (no longer at the ankle - this is now an adjustment in maintaining balance) is around the point of contact, the ball of the foot. Force - primarily from gastrecnemius and soleus (back of the leg) and to some extent from the peroneus longus and tibialis posticus (front of the leg). Resistance - lifting of the body weight.

b) Opening of the jaw.

G. Which is the mid-point in a third-class lever? (Force)

The resistance arm is always longer than the force arm. This type of lever favors range of motion and speed at the expense of force.

Demonstrate:

1. A door - which is closed by a spring.

2. In the body -

   a) Forearm - flexed by the biceps. Axis- the elbow. Force - the muscle pull (attached a short distance from the elbow). Resistance - weight of the hand and arm, plus the weight of an object in the hand.

   b) Most hip and knee muscles - operate these segments as third-class levers.

With few exceptions the levers of the body are of the third-class. Because muscles insert close to the joint and the weight (resistance) is concentrated farther from the joint. This results in a shorter force arm than resistance arm. Which means - the body favors - speed and range of movement at the expense of force.

H. How can we increase the force available within the body for accomplishing a desired task?

1. Use of machinery.

2. Use of sports instruments.

   Would a long instrument create more force or less force than a shorter instrument? What purpose does the sports instrument serve?

   a) More speed, thus, more force.

   b) Increases the length of the lever (arm).

3. Using a system of levers.

I. Experimentation:

1. Lifting a reasonably heavy object:

   a) Bend knees.

   b) Back straight (not bent at waist or hips).

   c) Lift mostly with the legs - extending them (or straightening them).

2. Underhand throw.(Review)

   a) Why the step (on the opposite foot) at release?

   b) Why the preparatory steps?

   c) Why the forward lean?

   d) Why the full pendulum arm swing?

   e) How important is timing in this skill pattern? Why is timing such a problem?

3. Pushing a heavy object (piano- parallel bars):

   a) How does the timing in this pattern of movement vary from that of the underhand throw? (All systems working at the same time)

XIII. MOMENT of INERTIA in ANGULAR MOTION --

A. The more compact an object around the axis the less the amount of inertia. The less power it takes to move it and the less momentum it will have.

B. The greater distance from the axis the force is applied the greater will be the rotation about the axis.

Experimentation:

1. Bent arm swing (just swinging the arm).

2. Fully extended, pendulum, arm swing.

3. Question the group about the difference in the, swing, power,

general feeling of the two arm swings.

4. Mention, again, the use of sports instruments.

XIV. AIR RESISTANCE --

A. You already know that air resistance increases as speed increases. Do you know why? (Counterforce)

Air resistance increases very rapidly as speed increases. As speed doubles, air resistance quadruples.

B. You also know that air resistance is very slight, except at very high speeds. Would you say that a light object will be affected more by air resistance than will a heavy object? (Yes) Why? (Momentum)

C. Demonstrate:

How the size, shape and weight of an object determine the air flow around it, or determine the effectiveness of air resistance.

(Be sure that the students are in a position to see the flight path of the objects)

1. Stroke a tennis ball.
2. Stroke a badminton bird.
3. What was the difference in the flight of the two objects?
    a) What was it that made the bird appear to stop it's forward motion, then fall to the floor?
    b) What forces were acting upon the bird and in what order? (air resistance, then, gravity)
    c) Why did the tennis ball come down more gradually?
    d) Were the same forces working upon the tennis ball as upon the bird?
    e) Why did air resistance have more influence upon the badminton bird?

4. Roll a playground ball as far as possible.

5. Roll a hockey ball as far as possible.

6. What was the difference in the two flight patterns? Why? The difference in distance? Why?

D. Remember, we have talked about linear and angular motion earlier?

1. What is linear motion?

2. What is angular motion?

When discussing rotary motion in relation to a ball it is usually referred to in terms of spin.

Spin builds up air pressure which in turn affects the distance and/or the direction the ball will travel.

XV. SPIN --

Remembering, angular motion in relation to a ball is usually referred to as spin and that spin builds up air pressure which in turn affects the distance and/or direction a ball will travel.

Using the information you have been given previously, let us do a little experimenting.

A. How do we impart top spin to the ball?

Experimentation: (Using the underhand toss, rolling a ball)

1. Will it be around a vertical or horizontal axis? (Horizontal)

2. We must spin the ball around its horizontal axis in such a way that the top of the ball is spinning forward, in the same direction that the ball is moving.

3. Force is applied through the center of gravity--palm of the hand under the ball--pulling it up quickly at the release, keeping the thumb up.

4. What affect does this have on the speed of the rolling ball? (Increases it)

5. What affect does it have on the direction of the ball? (None)

B. How do we make the ball curve to the right?
Experimentation: (Underhand-rolling)

1. Will it be around a vertical or horizontal axis? (Vertical)

2. Force is applied off center (not in line with the center of gravity), but on which side?

3. Application of force takes place as the hand moves from a position behind and under the ball to a position on the left side and under the ball, in a clockwise position.

   a) The starting hand position is with the palm of the hand under the ball and the thumb on top of the ball (a 12 o'clock position).

   b) Just before the ball is released the wrist is supinated (or rotated to the right) causing the fingers to apply force on the left side of the ball. The thumb moves from a 12 o'clock position to a 3 o'clock position.

   c) The faster the ball is traveling the later the curve effect will occur.

C. How do we make the ball curve to the left?
Experimentation: (underhand, roll)

1. It must be around a vertical axis.

2. Force is applied off center, again. This time it is applied on the forward, right side of the ball and moves to the left during the application (counter clockwise direction).

   a) The starting hand position is with the palm of the hand under the ball and the thumb on top of the ball, again, in a 12 o' clock position.

b) Just before the ball is released the wrist is rotated to the left which causes the fingers to apply force on the right forward side of the ball. The thumb moves from a 12 o'clock position to a 9 o'clock position.

c) Again, the faster the ball is traveling the later the curve effect will occur.

3. Does this affect the speed of the ball? (No)

D. Roll two different weights of balls.
Experimentation: (underhand, roll)
1. Light.

2. Heavy.

3. Compare difference in curve affect.

Which of the two curves sooner? Why?

E. Spin does increase the difficulty of accuracy in hitting a desired target. This can be controlled by knowing how much spin to impart and learning to apply the same amount of spin each time the ball is hit or released. This is the reason for starting the underhand toss with the hand (in relation to the ball) in a specific position.

XVI. REBOUND --

A. Unless there is spin on the ball and there is a lack of firmness of the ball or the object being hit, the angle of rebound will be the same as the angle at which contact is made.

B. If there is spin on the ball the principles concerning spin would apply in this situation.

C. The direction of the rebound will be changed if the striking surface of the ball"gives" at impact. The direction of the rebound will also be changed if the object being struck "gives" at impact.

D. The force of the rebound will depend upon the momentum of the striking object in addition to the momentum of the object being struck. If the object being struck is stationary, inertia of the object will still be an important consideration.

E. We are pulling from information we have already had in studying - momentum and absorbing force, in which force at impact and transmitting momentum from one object to another were discussed.

F. Will the stationary object offer any resistance? Will the ball rebound at all? If so how do we know in which direction it will rebound?

Experimentation:

1. A light ball is rolled in such a manner that it contacts a stationary object (hit the object "head on").
2. A heavier ball is rolled at the same stationary object (hitting the object in the center).
3. Discuss the difference in rebound for both the ball and the object, in each situation.
4. What would be the affect if the object struck was huge and very heavy? (The object would not rebound but the ball would) Would the rebound be faster than it's approaching momentum.
5. Roll the ball so that it strikes the object on it's left side.
6. Roll the ball so that it strikes the object on it's right side.
7. Discuss the difference (direction) of rebound for the ball and the object.

MOTOR PATTERNS -- TEACHING UNIT

I. STANDING --

A. Standing is not static, it is balancing on a stationary base. Thus the main concern in standing is stability.

There is a constant sway of the body in the positions we usually refer to as static. In standing this is due to the alternate dominance of anterior and posterior muscles.

The extensors tend to draw the body weight backward, the awareness of this backward movement automatically causes contraction of the antagonists, and the body then sways forward. This forward sway is a stimulus to the extensors, and in this manner the process continues.

Attempts to eliminate this sway result in discomfort and often in feeling of faintness. This swaying motion is important in the process of returning venous blood to the heart.

B. Most people do not stand in a balanced or well aligned position. The correct standing position is one in which the various body segments are balanced above each other so that there is a minimum of :

1. Friction and uneven pressure in weight bearing joints.
2. Strain on muscles and ligaments.

There should be a margin of safety in every joint so that an unexpected force will not push the joint beyond its normal limits which would result in injury.

The metabolic cost of standing is slight but the affect of various positions upon efficiency of movement are not slight. Faulty mechanics can cause a variety of painful conditions:

1. Pressure by bone, cartilage, or taut muscles on any part of a nerve.
2. Stretch or strain of a muscle, tendon or ligament which contains nerve endings.

Sudden severe stress can result from the accumulative efforts of constant or repeated small stresses over a long period of time.

C. Effective, efficient, posture is that position in which the center of gravity of each body segment is centered over the segment immediately below, so that the muscular effort on one side of the body equals that on the other side. In this balanced position the force of gravity is used, as much as possible, to maintain the alighment in the weight bearing joints.

The more nearly the center of gravity of the body is centered over its base the more stable the object and this stability is maintained with a minimum of strain, on the body.

Because the human body is made up of various segments which are held together by muscles and ligaments it does not fall apart when one segment is out of line with the part below. Because gravity tends to pull this segment downward, the center of gravity of the total body shifts in the direction of the out of line segment and another segment must be displaced in the opposite direction to bring the center of gravity back over the supporting base.

Explain and demonstrate this to the group!

D. Balance must be maintained in both the anteroposterior (forward-backward) plane and the lateral (sideward) plane.

1. Feet --

   a) Feet should be a few inches apart, giving as large a base as possible without producing a diagonal force against the ground.

   b) Toes should be pointed straight ahead, allowing the weight to fall on the heels and the outer borders of the feet. The outer portion of the foot supports body weight and the inner border absorbs force which reduces the jar to the body with each walking step.

2. Knees --

   a) Knees should not be hyperextended because the bones of the knee are forced together. If any backward force should be applied against them there would be no margin of safety.

      Hyperextention of the knees causes a forward tilt of the pelvis, which requires a greater muscular force for maintinance.

   b) The most efficient and the safest position of the knees is "easy" leaving some margin for backward movement.

3. Pelvis --

   a) The pelvis is the major connection between the upper and lower segments of the body. Any shifting of its position requires considerable readjustment of all the body segments.

   b) The pelvic girdle should be held in a balanced position, centered directly above the legs.

c) The control of this segment of the body is extremely important in the ability to assume and maintain a well aligned position.

4. Shoulder Girdle --

a) Shoulders should be balanced above the hips.

b) The shoulders should be level.

c) The shoulders should point directly out to the sides.

If one shoulder is carried higher than the other, the upper spine is curved to that direction and this causes the vertebrae to be tilted, the result being uneven pressures in the joints.

If the tips of the shoulders are carried forward the rib cage is depressed.

Throwing the shoulders back causes flattening of the upper back and it also increases the lower back curve.

As well as causing tenseness throughout the body, it results in wasted energy, fatigue and strain.

d) The shoulders should be relaxed.

5. Head --

a) Because the head is heavy and is attached to the rest of the body by a relatively small flexible segment (the neck) it is important that it be well balanced above the shoulders.

b) The head should be carried level to allow for the best possible line of vision and to avoid strain on the muscles of the neck and shoulders.

c) The top of the head should be up.

E. Balanced posture contributes to:

1. Increased endurance(delays fatigue).
2. The ability to move quickly.
3. The decreased incidence of strain or injury to muscles, joints, ligaments and/or tendons.
4. A better appearance in all clothes.

Experimentation by Students -- with Various Standing Positions

A. Toes out, toes in.

B. Feet too far apart, feet too close together.

C. Knees hyperextended, bent too much.

D. Pelvic tilt too far forward, too far back -

Make a point of the involvement of knees and the rest of the body.

E. One shoulder high, shoulders too far back, shoulders forward.

Again, making a point of the involvement of the entire upper portion of the body.

F. Chin too far down, chin too far forward, head cocked to one side,

Discuss the difficulty with vision in each of these head positions.

II. BALANCING WEIGHT ON ONE FOOT --

This occurs in each walking step for a brief period, it is for such a brief period it causes no difficulty, except when first learning to walk. Also, weight is balanced on one foot during the performance of certain stunts, dance routines and during the performance of various sport skills (kicking, sliding, and throwing).

A. The problem is balancing the human body on one foot is that the total weight must be centered over a smaller base.

B. When standing upright, the anteroposterior balance is the same as when on both feet.

C. However, this position does create a problem with lateral balance.

D. Common adjustments for correcting lateral balance are to raise the arms and shift the trunk position.

E. When these adjustments do not maintain balance, the supporting foot begins to invert or evert depending upon the weight shift.

F. If this does not maintain balance then movement of the supporting foot seems to offer a counteraction against which the weight can be shifted back into line.

G. If the body weight shifts completely outside the base of support, the individual is likely to take a hop in an effort to re-establish a base of support.

H. If this fails, the other foot must be placed on the ground in order to form a larger base(or completely lose balance).

I. If the trunk and arms are extended forward one leg is extended backward as a counterbalancing force.

<u>Experimentation by Students</u> -- with Various Body Positions in which the Weight is On One Foot --

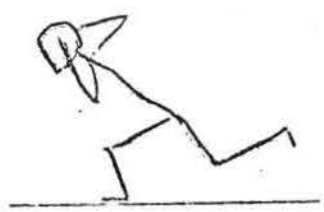
A. Standing on one foot with arms at sides and body in an upright position.

B. Standing on one foot with the upper body inclined forward. Give no other instructions, after the students have had a time to practice, discuss the adjustments which were made in order to maintain this position.

C. Assume a position on one foot with the trunk inclined forward, arms extended out to the sides and head up. Maintain this position as long as possible. Discuss the the adjustments that were made.

Students will assume and maintain the following body positions for as long a period of time as they can manage;

D.



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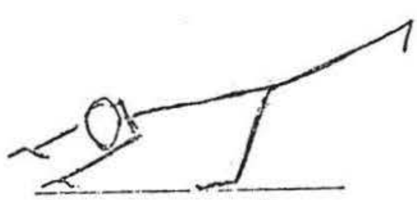

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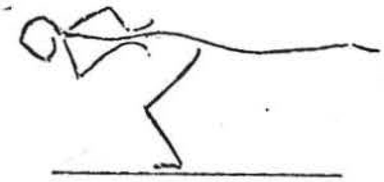

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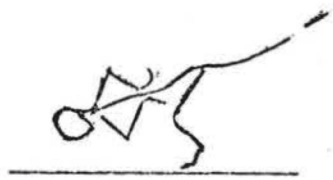

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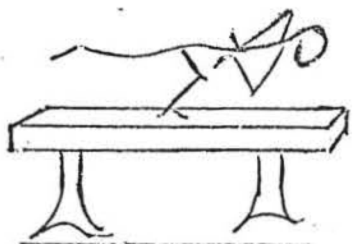

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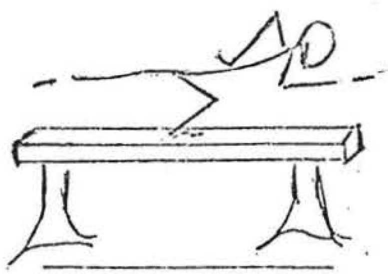

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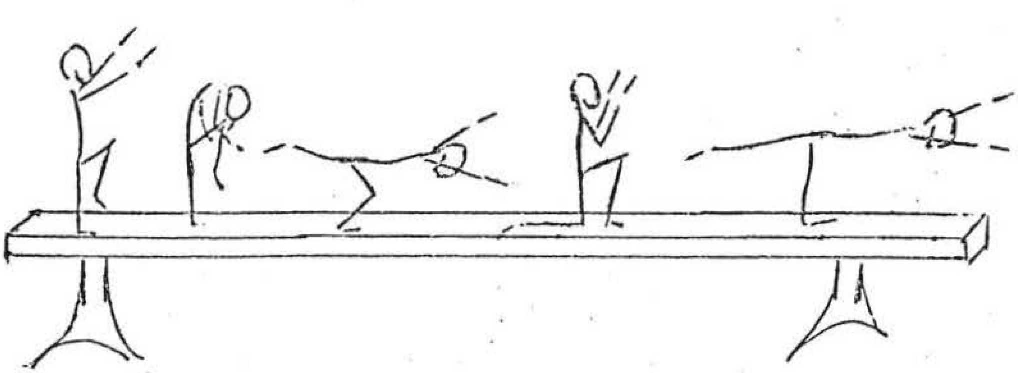


This one should be done in sequence, without stopping.

III. WALKING --

A. The general body position in walking is the same as it is in standing, a well aligned position.

Walking is a process of intentionally disturbing the balance of the body, pushing the body forward and re-establishing a new base. A process in which the ecnter of gravity of the body is constantly changing.

B. In walking inertia must be overcome, this is accomplished by the:

1. Force of the pushing foot.
2. Downward pull of gravity as the body is pushed forward.

C. The stability of the body is directly related to the size of the base. Thus the lateral distance between the feet becomes important.

D. The toes should point straight ahead and the inner boarders of the feet should fall along either side of a straight line, to eliminate sideways shift of weight and waste of effort.

E. The arm swing should be in opposition to the swing of the legs in order to reduce trunk rotation and to add to the momentum of the force of the movement. The bending of the arms shortens the lever and makes possible faster movement of the arms.

F. There is a short period of double support in every step when walking forward. The slower the walk the more overlap there is of the supportive phase of the two feet.

G. Since the body as a whole moves forward, walking can be described as linear motion. It is important to understand, however, that this linear notion of the body is brought about by two rotary motions of the legs.

H. In the act of walking each leg exerts force to propel the body forward, goes through a swinging phase, and then exerts force to resist the forward movement of the body. When the foot strikes the ground after the swinging phase, there is a backward counterpressure of the ground against the foot which checks the forward momentum of the body. This is what makes it possible to stop the forward momentum of the body at any point in the walking sequence.

Demonstrate this with a very fast walk and a run.

I. More force can be applied in the direction of the movement if the center of gravity of the body is inclined forward. This incline should be from the ankles, thus keeping the body segments balanced.

Demonstrate this by walking with the weight well back and then switching the weight forward (bent at the hips).

The speed of the walk is determined by:

1. The magnitude of the pushing force, which depends upon:
   a) Force exerted by the foot. (ice)
   b) Resistance of the ground. (lose sand)
2. The direction of the application of the force.

Friction is necessary if the counterforce of the surface is to be transferred to the body. If there were little or no friction the backward component of the pushing force would simply move the foot backward across the surface. The more vertical the application of the force the more effective the friction. The less the friction the less the force. Shortening the steps keeps the center of gravity vertically above the base thus increasing friction.

J. <u>Experimentation</u>:

1. Walking on a straight line (one actually marked)- turn quickly to face the opposite direction without missing a step- and continue to walk the same line- in the opposite direction.
2. Discuss the sensations felt and the movements employed to maintain balance.
3. Walking on the balance beam, just a plain walk and a walk in which the free foot is swung slightly out and forward.
4. Several walking steps (on the floor) and a slide on one foot, no limits on the area in which this must be done.
5. Several steps and a slide within a given area.
6. Note the movements employed to maintain balance and discuss advantages and disadvantages.

IV. HOLDING and CARRYING --

A. When an object is held it becomes a part of the total body weight and the center of gravity of the body, plus the weight being held, shifts in the direction of the weight.

If stability is to be maintained this new center of gravity must be shifted back over the center of the base.

1. If this adjustment is made by shifting the body as a unit from the ankles, the alignment of the various segments is not disturbed.

   The use of the total body as counterbalance for the weight held reduces the possibility of strain on various muscles and joints.

2. The nearer the weight is held to the body's center of gravity the smaller the rotary force exerted upon the body.

B. Weights that are held above or below the center of gravity of the body are compensated by excessive leaning.

This leaning usually involves strain upon the lower spine.

C. A weight held only on one side of the body requires support by the trunk muscles of the opposite side as well as the arm and shoulder muscles on the carrying side. The strong downward pull of the weight upon wrist, elbow, and shoulder requires muscular pull at all joints of the arm which results, primarily, in a stabalizing force.

D. A weight should be held as close as possible to the body in order to shorten the weight arm.

An object (not too heavy) carried at one side of the body can be counterbalanced by raising the opposite arm sideways, thus making it possible to keep the body in the same basic alignment. Remember, the reaction of a lever is in proportion to it's length. The fact that it is a considerable distance from the line of gravity of the body and the added weight is closer to the line of gravity makes it an effective counterbalance.

E. <u>Experimentation:</u>

1. Hold a (5lb.) weight, with both hands, out in front of the body at about eye level.
2. Hold this same weight in close to the body, at about waist height.
3. Compare the differences in the difficulty of the two positions.
4. Repeat 1 and 2 using an (8 lb.) weight.
5. Hold a weight, in one hand, out to the side of the body. The weight is on both feet and the free arm is down at the side.
6. Hold the same weight, in one hand, out to the side of the body. This time the weight may be shifted and the free arm may be raised in an effort to counterbalance the weight.

7. Discuss the difference in the feeling in each of the positions.

   a) Which direction should the weight shift?

   b) How should the weight be shifted? At the hips? At the ankles?

   c) In what position should the free arm be, in order to be of the best assistance?

      (1) Forward?

      (2) Backward?

      (3) Straight out to the side?

V. UNDERHAND THROWING PATTERN --

A. We have already learned that momentum can be transferred from one part of an object to another part of that same object. In this case we will be talking in terms of transferring the momentum of the body to a ball.

B. Upon being released the ball will move at this same momentum (velocity) and in the same direction until acted upon by other forces such as, gravity, air resistance or friction.

It becomes apparent that we must give some thought to developing speed and to controlling the direction in which the ball travels.

C. Speed

1. The faster the hand is moving at the moment of release the faster the object will move, whether thrown or rolled.
2. Increasing the backswing increases force because the duration of the application of force has been increased.
3. The more body parts that contribute to the movement the greater the speed of the motion. For maximum speed each body part must come into action at the correct moment (coordination), at the time when the part below has reached it's maximum speed.
4. The shifting of the body weight forward with the throw forces more body parts into action and also makes possible a bigger(higher) backswing.

5. When shifting the weight forward in the direction of the throw it is important <u>not</u> to offer resistance to the forward momentum. This can be accomplished by bending the knee of the forward leg and allowing a slide on this step.

6. When rolling a ball, in order to place the ball on the floor, it becomes necessary to lower the body and also to slightly incline the body forward. If the lean is too far forward it creates a very unstable position and in an effort to maintain balance, will cause strain on the back.

7. This can be counteracted by emphasizing the lowering or bending aspect with a minimum of forward lean and by moving the opposite arm backward and upward at this moment.

8. Increasing the speed of the steps in the preperation for the throw or roll increases the speed and consiquently the force applied to the object.

9. Throwing while moving requires a great deal of balance and, as we have learned before, will require taking small steps.

10. The moment of release should be at the moment of maximum momentum if the object is to receive maximum speed. The hand is moving it's fastest at the mid-point of the arc, therefore the object should be released as near this point as practical.

11. If the hand is jerked back or stopped immediately after release, the arc is shortened and the speed of the hand must be slowed before the object leaves the hand. This is true because human muscles can not stop momentum suddenly, without injury, speed must be reduced gradually. A jerking back to stop momentum also produces a counterforce which acts against the forward force. The followthrough (contimuing of the arc) allows the maximum momentum to be transferred to the object.

12. Whether or not all the force that can be produced by the body is necessary depends upon the purpose of the throw. If the throw does not require maximum speed the movement should be adjusted accordingly.

D. Direction --

1. Direction control requires adjusting the angle of release in both the:

   a) Vertical plane.

   b) Horizontal plane.

2. When rolling an object the vertical plane <u>should</u> not be involved but friction does become an important factor.

If the hand is moving in an arc the principle of centrifugal force is involved. What is the principle? What does it mean in this particular situation?

It means there is only one point on the arc at which the ball can be released if it is to travel in the desired direction.

3. The flatter the arc in which the hand is moving the greater the potential for accuracy.

   The arc may be flattened by:

   a) Bending the knee of the supporting (forward) leg.

   b) Moving the shoulders (center of the arc) forward and downward.

4. The distance an object will travel depends upon:

   a) The force imparted to the object at release.

   b) The angle at which the object is released.

   c) The counteraction of outside forces.

So, it becomes necessary to adjust the speed and the angle of release according to the purpose of the throw.

E. In the underhand throw the angle at which the ball is released is reduced in order that the force may be applied directly behind the object thus making maximum use of the force available.

F. Gravity pull is not a major consideration in the underhand throw, in which an object is to roll, as it is in the overhand and sidearm throws. However, gravity pull must be considered at the moment of release and during the backswing and swingthrough of the arm when rolling an object.

G. Top spin and back spin have no effect on the direction of of a rolling ball, they do have an effect upon the speed of the rolling ball.

H. Side spin does have a definite effect upon the direction of a rolling ball.

I. Remember our discussion about momentum in which we learned that a heavy object has greater inertia than a lighter one and therefore it takes greater force to throw or roll this heavy object. However, once the force is applied the object travels faster than a light object because of it's ability to overcome air resistance and of course because of it's mass.

J. With the same amount of force applied a smaller object which weighs the same as a larger one will travel faster and farther because of the decrease in air resistance.

This is due to the difference in surface area presented in the direction of the momentum.

K. Remember also, that an irregular surface on an object will increase air resistance and will therefore reduce the distance it will travel with a given amount of force.

L. The underhand throwing pattern is particularly adaptable to throwing or rolling heavy objects(ball in this case) because:

1. The object is held close to the body center of gravity.
2. The arm is extended in preparation for the throw. Why is this an advantage?

M. Each of these aids in the control of the object and the body through-out the throw. The straight arm decreases the need for additional strength production since it is in a position in which the use of gravity may be easily employed. The ability to keep the ball close to the center of gravity of the body increases body balance through-out the throw.

N. Analysis of the underhand throw:

1. The object must be pushed away from the body as an initial preperation for the throw.
2. The object is now in a position in which gravity can aid in the dropping and backward movement.
3. As the object reaches the height of the backswing gravity again assists in the swing-through (forward swing of the arm), since the arm swing is in a vertical plane.
4. As the object is released it has gained forward momentum through the assistance of the pull of gravity.

O. Individuals who are extremely weak may compensate with this pattern by placing the palm of the hand and arm in such a position that they can assist in the support of the object during the execution of the throw. It is important to realize that this is not the most advantageous position for the hand and arm but is is one way to compensate for lack of strength.

P. This pattern of throwing (underhand) is <u>not</u> the most effective when maximum speed or distance are required because the backswing and body rotation are limited.

Q. This pattern <u>is</u> most effective in situations where control and accuracy are important factors, because the throwing hand follows a straight path through-out the total pattern of movement. Accuracy is almost completely a matter of controling the vertical release. The right and left movement (horizontal) <u>should not</u> be a consideration.

R. Factors which increase speed and distance:

1. Starting the ball in a higher position.
2. Body slightly inclined forward (flattening the arc).
3. Increased backswing(balance limits this some).
4. Transfer of weight at release.
5. Bending forward knee and sliding on last step.
6. Increase speed of steps.
7. Increase the speed of arm-swing.

S. As force is increased balance will become more of a problem. This problem can be controlled if the center of gravity of the body is kept low.

T. In throwing,the greater the distance the ball must travel before reaching the target the more important are control and accuracy at the moment of release.

A slight degree of inaccuracy at release becomes a greater degree of inaccuracy the further the object travels. If the distance to be covered is great then the object can completely miss the target due to a slight miscalculation at the moment of release. The longer distance the thrown object must travel allows more time for other forces to act upon it before hitting the target.

What are some of the forces which would act upon a rolling ball before it could reach it's target?

1. Friction.
2. Air resistance.
3. Spin

U. Experimentation:

1. Feet in a balanced position (few inches apart), just standing in place, with very little backswing, roll the ball.
2. Same starting position with the feet, still just standing in place, increase the backswing (shoulder high), roll the ball.
3. Same starting stance, take 4 steps forward during the backswing and the swing-through, release the ball.
4. Starting stance, before the 4 steps are started, incline the body slightly forward (from the ankles), on the 4^{th} step bend the forward knee and slide, release the ball. Be certain the 4^{th} step is with the foot opposite the throwing arm.
5. Repeat, execute the 4 steps in a shorter period of

time (speed up the entire throwing pattern).

6. Repeat, this time emphasize holding the ball close to the body (about waist high) then pushing the ball forward away from the body, as the arm with the ball swings back and down the opposite arm should be moved out to the side and up in order to offer a counter balance for the body. The heavier the ball being thrown the more important the balancing effect of the non weight bearing arm.

7. Since the object is to roll the ball and not throw it. The moment of release should be at what point in the arc? If maximum force is to be applied directly behind the ball? Just as the arm begins it's upswing (just past the mid-point of the arc).

8. Repeat the throwing pattern with all the additions, this time making certain to continue the arc after the ball has been released.

9. Repeat the complete pattern this time with the addition of, pointing the throwing hand right at the target (through the middle of the target) as the hand continues through the arc.

Name ______________________________ Dorothy M. Coleman

MOVEMENT EDUCATION UNIT EXAMINATION

INDICATE your choice of the ONE best answer to each question by marking an X in the proper space. If you change your mind erase the first mark completely.

1. Which of the following is true concerning the body and the difficulty of maintaining a balanced position?

   (a) a light body is easier to balance
   (b) a well aligned body is the least difficult to balance
   (c) a heavy body is easier to balance
   (d) it makes no difference how the body is sligned since the gravity pull is the same on all objects

2. The best standing position for the human body is:

   (a) feet a few inches apart with the knees slightly flexed
   (b) feet in a wide, side-stride position with the knees extended
   (c) feet in a wide, forward-stride position with the knees slightly flexed
   (d) feet in a wide, side-stride position with the knees slightly flexed

3. In which of the following will the center of gravity be the geometrical center of the object?

   (a) human body
   (b) tennis ball
   (c) shuttlecock (badminton bird)
   (d) arrow

4. Why is the position of the body not stable while running?

   (a) the supporting base is shifting
   (b) the supporting base is small
   (c) the center of gravity does not fall within the supporting base
   (d) center of gravity is too high

5. If the following objects are dropped to the floor from the same height, which would strike the floor first?

   (a) hockey ball
   (b) feather
   (c) tennis ball
   (d) they would all strike the floor at the same time

6. A paddling position in canoeing is an example of which of the following principles?

   (a) a body is balanced when it's center of gravity is over it's supporting base
   (b) the object is more stable if the line of gravity falls near the center of the base
   (c) the lower the center of gravity, the more stable the object
   (d) the larger the base, the more stable the object

7. When carrying an object heavy enough that both hands must be used, where should it be held?

   (a) approximately eye level
   (b) close to the body and approximately waist high
   (c) close to the body and approximately chest high
   (d) on the hip

8. When attempting to counterbalance a heavy object being carried on one side of the body, at what point should the body weight be shifted?

   (a) waist
   (b) hips
   (c) knees
   (d) ankles

9. Which of the following would require the greatest effort with the least results?

   (a) walking along the beach in loose sand
   (b) walking on ice
   (c) walking in stocking feet on a freshly waxed floor
   (d) walking in snow

10. When walking on a slick surface, which of the following body adjustments would be the most effective?

   (a) lean forward from the ankles
   (b) increase the arm swing
   (c) lengthen the stride
   (d) shorten the stride

11. Which factor causes a badminton bird to travel slower than a tennis ball?

    (a) longer force arm
    (b) air resistance
    (c) length of backswing
    (d) more inertia to over come

12. Which of the following slow rolling objects will encounter the greatest amount of air resistance?

    (a) bowling ball
    (b) softball
    (c) basketball
    (d) tennis ball

13. Sports instruments:

    (a) lengthen the levers of the body
    (b) add to the balance of the body
    (c) increase the accuracy of the movement
    (d) all of the above

14. A long backswing, transfer of weight and rotation of the body are applications of what principle?

    (a) lengthening the levers of the body
    (b) a longer lever gives increased speed
    (c) use of the whole body as a lever gives increased force and speed
    (d) third class levers favor fast movement with light objects

15. The straightening of the arm in preperation of an underhand throw, is an example of:

    (a) a 1st class lever
    (b) a 2nd class lever
    (c) a 3rd class lever
    (d) more than one type lever

16. Human movement involves which of the following:

    (a) resistance to motion or change of motion
    (b) change in velocity
    (c) opposing force
    (d) all of the above

17. Which of the following is the best example of rotary motion?

(a) walking
(b) a rolling ball spinning to the right
(c) downhill skiing
(d) executing a golf swing

18. Which of the following is the best example of linear motion?

(a) coasting straight down hill on a sled
(b) riding in a car down a straight highway
(c) cutting a piece of paper with scissors (straight cut)
(d) the flight of a golf ball after it is hit

19. A small heavy ball, as compared to a large ball of the same weight, will:

(a) require more power to move it
(b) have more momentum
(c) require less power to move it
(d) travel a greater distance

20. The primary contribution of a sports instrument used as an extension of the arms or legs, is:

(a) increased force
(b) increased accuracy
(c) increased balance
(d) increased speed

21. Which of the following explains why it is impossible to stop immediately while running?

(a) momentum of the body
(b) inertia of the body
(c) acceleration of the body
(d) application of counterforce is too slow

22. Which of the following will result in the greatest increase in momentum?

(a) full swing with a badminton racquet
(b) bent arm swing with a tennis racquet
(c) full arm swing with a baseball bat
(d) bent arm swing with a golf club

23. When throwing, what is the purpose of taking several running steps before releasing the ball?

(a) gain momentum
(b) increase balance
(c) improve coordination
(d) increase counterforce

24. Shifting the body weight while executing a throwing skill contributes primarily to:

(a) control
(b) force
(c) accuracy
(d) speed

25. The process of taking a backswing when striking or throwing allows:

(a) for the lengthening of the lever
(b) time to adjust accuracy of the swing
(c) an increase in time that force is applied to the lever
(d) time to establish balance

26. The body is inclined forward when running in order to:

(a) keep the force behind the body
(b) make use of the pull of gravity
(c) reduce air and/or wind resistance
(d) all of the above

27. When throwing a ball, the direction of the path of the ball will be determined primarily by:

(a) the position of the feet at the moment of release
(b) the position of the hand (on the ball) as it is released
(c) the direction of the follow-through
(d) all of the above

28. When throwing a ball in such a manner that it will roll, the application of force will result in:

(a) forward movement
(b) increased friction
(c) downward movement
(d) all of the above

29. When executing an underhand throwing skill, the bending of the forward knee with a slight incline of the body as the ball is being released will:

(a) increase counterforce
(b) enlarge the base of support in the direction of the force
(c) reduce momentum gradually
(d) increase resistance so that forward motion will be stopped

30. The time necessary to stop a moving object depends <u>primarily</u> upon:

(a) momentum of the object
(b) speed of the object
(c) weight of the object
(d) all of the above

31. A rolling ball which curves to the right:

(a) is turning about it's horizontal axis
(b) has built up a greater pressure on it's right side
(c) is turning about it's vertical axis
(d) is turning about both vertical and horizontal axes

32. Which of the following <u>best</u> describes the path of a <u>fast</u> rolling ball with clockwise (right) spin on it?

(a) curves to the right
(b) curves to the left
(c) goes straight then curves to the left
(d) goes straight then curves to the right

33. The off-center application of force to an object will:

(a) cause the object to move in an angular path
(b) cause the object to move in a straight path
(c) decrease the difficulty in hitting a desired target
(d) increase the distance the object will travel

34. The rebound force of a solid ball off of a solid, stationary object depends upon:

(a) spin on the ball
(b) inertia of the stationary object
(c) momentum of the ball
(d) all of the above

35. The result of a solid, heavy ball striking a solid, lighter, stationary object is:

(a) the ball will experience the greatest rebound force
(b) the object being struck will experience the greatest rebound force
(c) both the ball and the object being struck will experience the same rebound force
(d) the stationary object will offer considerable counterforce

36. Which of the following is the major factor in determining the angle of rebound of a solid ball from a solid, stationary object?

(a) momentum of the ball
(b) weight of the stationary object
(c) the point at which the ball hits the object
(d) weight of the ball

37. Which of the following will contribute to an increase in accuracy in executing a throwing skill?

(a) stepping forward with the foot opposite that of the throwing arm
(b) follow-through toward the target
(c) arm swing involving only the vertical plane
(d) all of the above

38. The underhand throwing pattern is best for:
(a) accuracy
(b) force
(c) distance
(d) speed

BOWLING UNIT

I. HISTORY --

Records reveal that a primitive form of bowling was played by the Egyptians as far back as 5200 B.C.. Bowling is thought to have originated as a religious ceremony in Germany during the third and fourth centuries A.D.. The term "Kegler" dates back to this period of time when the German men carried a small wooden club called a "Kegel" which was used for strengthening wrists, for recreation, and for religious ceremony. After the religious ceremony was abolished the game of bowling continued because of its recreational value.

During the Middle Ages many variations of the game developed throughout Europe. There is evidence that a form of bowling was played in northern Italy more than 1,000 years ago. Martin Luther, an enthuastic bowler of the 15th century, published a set of rules for a game of nine pins. "Nine pins" was played in Holland, "boccie" in Italy, "skilles" and "lawn bowls" in England, "curling" in Scotland, and "keys" and "billards" were variations of the game in France.

The nine-pin game originated with the Dutch, who introduced it to Colonial America and it is this game which the present game most resembles.

Indoor ten-pin bowling is typically American, the tenth pin was added after nine-pin bowling was declaired illegal in New York, Connecticut, and Massachusetts.

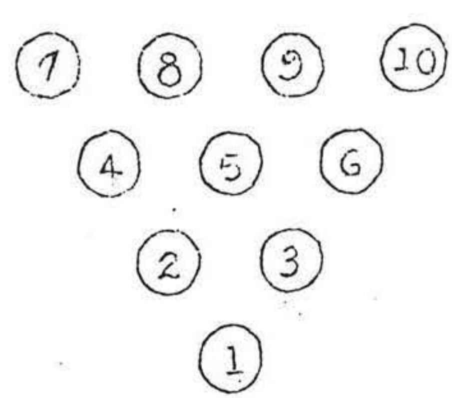
The American Bowling Congress was organized in 1895, the organization which governs men's league bowling. The Women's International Bowling Congress was organized in 1916. These two organizations are responsible for organizing and standardizing rules, equipment and alleys, conducting national, regional and state tournaments,and providing leadership to the sport.

Twenty million Americans enjoy the sport of bowling. The automatic pin setters, emphasis on convenience, comfort and wholesome atmosphere have been responsible for attracting so many Americans to bowling establishments. Bowling is good exercise for young and old alike, from 8 to 80, the family, and for many handicapped people.

II. THE GAME --

Bowling as we know it today is played on indoor wooden alleys (lanes), 60 feet in length (from foul line to the number one pin) and 41 or 42 inches in width.

The tem pins are set up in a triangular formation on spots 12 inches apart (from center to center). The pins are round and wooden, 15 inches high and weigh not less than 2 pounds, 14 ounces and no more than 3 pounds, 10 ounces. The pins are numbered from 1 to 10 (from left to right).



The bowling ball may not be more than 27 inches in circumference and not more than 16 pounds or less than 10 pounds in weight. Usually the bowling ball is bored with three holes, it can be less or more, there is no strict rule concerning this.

Good bowling shoes have one sole of leather and the other of rubber to insure balance and proper delivery. An individual should never bowl without bowling shoes.

A game consists of 10 frames. A player is entitled to roll two balls in each frame unless all pins are knocked down with the first ball; in which case only one ball is rolled in that particular frame, this applies for all the frames except the tenth. In the tenth frame, if all pins are knocked down with the first ball, the bowler immediately rolls two additional ones in order to complete the game. If all remaining pins are knocked down with the second ball (spare) in the tenth frame, the bowler immediately rolls one additional ball to complete the game.

A bowler should not touch the foul line. Touching the foul line is illegal and all pins knocked down on such a delivery will not be scored. A foul on the first attempt does not nullify the opportunity to roll a second ball. If the pinsetters do not automatically re-set pins after a foul, the reset button must be used.

When two or more persons are bowling, they should take regular turns on the lane. When participating in team bowling, teams alternate lanes, the first bowler of each team follows the last bowler of the other team.

The objective in bowling is to knock down all 10 pins with a maximum of two attempts, preferably with one attempt, in each frame.

III. SCORING --

As previously indicated a complete game consists of ten frames. On the score sheet, in each of the ten frames there will be one or two small squares. The pin count for the first attempt should be scored in the first small square. If there is only one small square in the frame, this pin count is recorded in front of the one square. The pin count for the second attempt is recorded in the second small square.

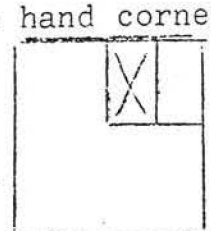
Always keep the pin count for both attempts in every frame! This is very important in that the bowler will have an accurate record of his game. The accurate recording of both attempts can indicate many of the problems which plague the bowler.

Scoring is a matter of adding the number of pins knocked down in each frame and carrying the cumulative total in each succeeding frame.

The following are symbols used in scoring a game of bowling:

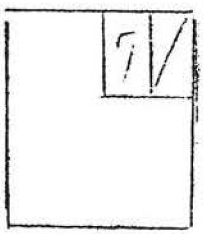
A. Strike --

An X is recorded when the bowler completes a legal delivery and knocks all the pins down with the first attempt. A strike counts 10 plus the pin count of the next two balls rolled. The strike is recorded in the first small square in the upper right hand corner of the frame.



B. Spare --

A / is recorded when the bowler completes a legal delivery and knocks down all the remaining pins with the <u>second</u> attempt (ball). A spare counts 10 plus the pin count of <u>the next</u> ball rolled. The spare is recorded in the second small square in the upper right hand corner of the frame.



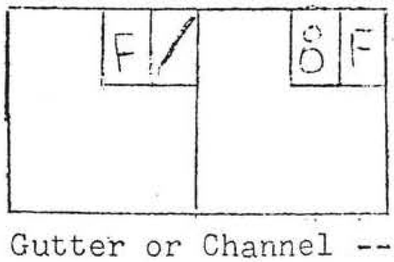
C. Foul --

A foul ball is recorded as a ball rolled but any pins knocked down shall <u>not</u> count.

If a bowler fouls on the first attempt in a given frame, no pin count is scored and the pins are reset. Only the pins knocked down by the second ball will be counted.

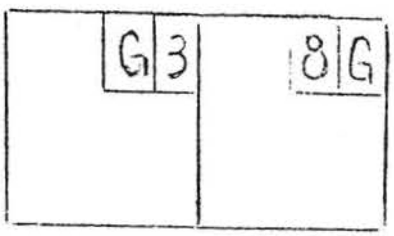
If a bowler knocks down all pins with the second attempt, after fouling with the first, it shall be scored as a spare.

If a bowler fouls on the second attempt only the pins knocked down with the first ball shall be scored. A foul is designated with an F in one of the squares in the upper right hand corner of the frame.



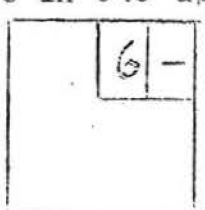
D. Gutter or Channel --

If the bowling ball goes into the gutter, on either side of the lane, before reaching the pins it is considered a gutter ball. A G (be certain it does not resemble a six) is recorded in one of the small squares in the upper right-hand corner of the frame.



E. Error --

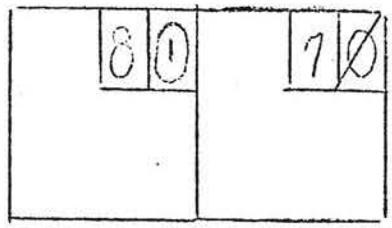
An error is made when the bowler fails to bowl down all ten pins after two deliveries in a given frame, providing the pins left standing after the first attempt do not constitute a split. The symbol indicating an error is used <u>only</u> if the ball stays on the lane but hits no pins. If pins are bowled down on the second attempt, the pin count should be recorded. A - is recorded in the second small square in the upper right hand corner of the frame.



F. Split -

A split is a setup of pins that remain standing after the first ball has been legally delivered, provided the head pin (no. 1) is not standing and at least one pin is down between two or more standing pins(7-10) (3-10) (10-5-7). A split is designated by a O in the second small square in the upper right hand corner of the frame. Any pins bowled down with the second attempt are scored inside the

Dorothy M. Coleman

circle. 

IV. EXAMPLE OF SCORING --

Frame 1 - first attempt; 8 pins bowled down, 4-7 pins still standing, second delivery; both pins knocked down.

Frame 2 - first delivery; a gutter ball, second attempt; six pins knocked down.

Frame 3 - first attempt; 7 pins bowled down, 1,3,10 pins still standing, second attempt; in bowling the remaining pins down step over the foul line.

Frame 4 - first attempt; strike.

Frame 5 - first attempt; 5 pins down, second attempt; all remaining pins bowled down.

Frame 6 - first ball; bowler steps on the foul line and gets a strike, second ball; all pins bowled down.

Frame 7 - first ball; 7 pins down, second ball; ball stays on the alley but hits no pins.

Frame 8 - first delivery; 5 pins down, second delivery; 2 pins down.

Frame 9 - first attempt; 7 pins down, 7-5-10 pins still standing, second attempt; ball stays on the lane but hits no pins.

Frame 10 first ball; strike, second ball; 6 pins down; third ball; all remaining pins knocked down.

8 /	G 6	7 F	X	5 /	F /	7 -	5 2	7 ⊖	X 6 /
10	16	23	43	53	70	77	84	91	111
1	2	3	4	5	6	7	8	9	10

V. RULES --

A. No food or drinks should be taken up to the bowlers bench or to the score table.

B. Cigarettes should be deposited in the ash trays not on the floor.

C. Dress properly for bowling, wear loose- fitting clothes, not sloppy, just not tight.

D. Legal Pinfall --

1. Pins which are knocked down by another pin or pins which rebound from the side or rear cushions are counted as pins bowled down.

2. If immediately after the ball has been released, on either the first or second attempt, it is discovered that a pin is improperly set (not missing) the ball counts as bowled and the pinfall shall count.

3. Pins which are bowled down by a fair delivery and remain on the lane, in the gutters, or leaning against other pins or side cushions, are considered dead wood and counted as pins down and should be removed before the next delivery.

E. Illegal Pinfall --

When any of the following incidents occur, the ball counts as rolled, but pins knocked down shall not count:

1. When pins are knocked down or displaced by a ball that leaves the alley before reaching the pins.

2. When the <u>ball</u> rebounds from the rear cushion.

3. When pins come in contact with the body, arms or legs

of a pin setter and rebound.

4. A standing pin which is knocked down when removing dead wood, shall not count and should be replaced to its original position.
5. If in delivering the ball a foul is committed any pins knocked down shall not be counted.
6. Pins which are bowled off the alley, rebound and remain standing on the alley must be counted as pins standing.

F. Dead Ball --

A ball is declared dead if any of the following occur, in which case the ball does not count as bowled. The pins are reset and the player bowls again.

1. Immediately after the bowler delivers the ball, attention is called to the fact that one or more pins are missing.
2. When a pin setter interferes with any pin or pins before the ball reaches the pins.
3. When a player bowls on the wrong lane or out of turn.
4. When a player is interfered with by pin setter, another bowler, spectator or moving objects as the ball is delivered but before it is completed, a player must at this moment demand that pins be reset or accept the resulting pinfall.
5. When the pins are moved or knocked down as the bowler is delivering the ball and before the ball reaches the pins.
6. When a bowling ball comes into contact with any foreign object.

VI. BOWLING ETIQUETTE --

A. Remain back of the foul line at all times.

B. Do not walk in front of or up beside a bowler to secure the bowling ball from the return rack when that bowler is ready to bowl.

C. Use one bowling ball only and wait for it to return.

D. Do not talk or otherwise distrub a bowler who is on the approach and ready to bowl.

E. When two bowlers on adjacent lanes are ready to start their approach at the same time the bowler on the right should bowl first.

If one player is ready to bowl the second ball of a frame that player should be allowed to bowl first.

F. Do not use a bowling ball that is the personal property of some individual with out the permission of that individual.

G. A player should be ready to bowl when it is his turn.

H. After delivering the ball and watching the results, turn and walk back to the rear of the approach.

A player should use only the width of his lane for any "contortions" or "body english" in which he wishes to indulge.

I. Use good sportsmanship at all times, appreciate and compliment good bowling.

J. A bowler should not make an issue of his "bad luck".

K. Do not get discouraged and remember that a bowler must think about what he is doing or not doing correctly.

VII. BOWLING TERMS --

Anchor - last bowler on a team.

Blow - an error.

Brooklyn - hitting to the left of the head pin for a right handed bowler, hitting to the right of the head pin for a left handed bowler.

Cherry - a ball that picks off the front pin of a spare and leaves the pin behind or to the right or left standing.

Cushion - the upholstered back portion of the pit.

Dog-leg - the 1-2-10 pins standing.

Double - two strikes in succession.

Double wood - one pin directly behind another.

Fence posts - the 7-10 split.

Foul - to touch or go over the foul line as the bowling ball is delivered.

Four-timer - four strikes in a row.

Full hit - when the bowling ball makes contact at the center of the pin, most often used in terms of the head pin.

Leave - the pins remaining after the first ball is thrown.

Light - a hit that is not full enough.

Loft - to throw the ball out on the lane, not placing it on the lane.

Mark - a strike or spare.

Open frame - a frame without a strike or spare.

Picket fence - the 1-2-4-7 or the 1-3-6-10.

Pocket - the 1-3 pins for a right hander, 1-2 for a left hander.

Powder puff - a slow ball that does not knock down all the pins.

Railroad - a split:

Baby split - 3-10 or 2-7.

Bed posts - 7-10 split, also snake eyes.

Big four - 4-6-7-10 split.

Christmas tree - 3-7-10 or 2-7-10 split.

Sleeper - a hidden pin.

Steal - to get more pins than deserved on a hit.

Strike out - to get successive strikes from any frame through the remaining frames of a game.

Thin hit - hit in which the ball barely touches the headpin.

Turkey - three strikes in a row.

Turkey out - three strikes in the last frame.

Washout - the 1-2-10 or the 1-2-4-10 spare.

Woolworth - the 5-10 split.

Working ball - a ball with great spin that produces a lot of action among the pins.

VIII. FUNDAMENTALS --

If an individual is to become proficient at bowling he must concentrate first upon the fundamentals of bowling and second practice until the performance of these fundamentals becomes habit.

It seems vitally important to stress the necessity for consistancy. It is extremely important that the bowler is able to execute the same approach, the same release, the same follow-through each time he bowls. When consistancy has been established it is relatively simple to adjust the point of aim in such a manner that spare bowling is most effective and efficient.

Consistancy is <u>more important</u> than force. Force is important to a point, that point is, <u>adequate</u> momentum of the bowling ball. Maximum application of force is almost never a consideration in bowling. Force is important to the extent that the desired rebound action of the pins results and this imvolves more factors than just the momentum of the bowling ball. Other factors which are involved include; spin(or lack of it) on the bowling ball, inertia of the pin or pins, and the point at which the bowling ball contacts the pin or pins.

The ability of the bowler to continually execute an efficient, effective; approach, release,and follow-through will determine that individuals ability to increase or improve his bowling scores and consiquently his average.

A. Selecting A Bowling Ball --

Bowling balls are usually bored with three holes. The holes should be large enough for the fingers to slip in and out easily. The thumb hole should be comfortably loose and the finger holes comfortably snug.

To determine the correct fit of the bowling ball, place the thumb completely in the thumb hole, the fingers (2nd and 3rd) should be relaxed and spread over the finger holes. The crease (wrinkles) of the second joint of the fingers should extend a quarter of an inch beyond the inside edge of the finger holes. Obviously,if the finger holes are too tight it will be difficult to release the bowling ball. If the finger holes are too loose the individual will have difficulty holding the bowling ball.

If the bowler must consciously think about holding on to the bowling ball, it does not fit. If it fits correctly it requires no conscious thought to hold it properly.

Women generally use a bowling ball which is lighter weight than those used by men.

As a bowler progresses in his ability to master the fundamentals it is usually wise to use a heavier bowling ball. The added weight decreases the effect of forces acting upon it and the heavier bowling ball will have greater momentum with less effort on the part of the bowler.

For the individual who plans to continue bowling it would be advantageous to buy a bowling ball which is drilled specifically to fit his hand. It is also important that the serious bowler own his own bowling shoes.

B. Approach --

The 3,4, and 5 step approaches are all acceptable.

The 3 step approach is most often used by very long legged individuals, who's steps are likely to be very long.

The 5 step approach is most often used by very small and short legged individuals who need the extra step in order to gain needed momentum.

The 4 step approach is generally accepted as the best and the one used most often. The primary reasons for this preference are, the coordination of arm and leg movements is less difficult and it provides very definite check points for the bowler through-out the approach.

In all of the approaches, the steps should begin very slowly and continue with short gliding steps, finishing with a slide on the forward foot with the knee bent and the body slightly inclined forward.

For the right handed bowler using the 3 or 5 step approach, the first step will be with the left foot. A right handed bowler using a 4 step approach would step first with the right foot in order for the last step to be on the left foot, which enables the bowler to make use of the principle of opposition.

The underhand throwing pattern (with some modification) is used in bowling.

1. Analysis of the 4 Step Approach --

Coordination of arm and leg movements (for right hander)

a) During the <u>slow</u> and <u>short</u> first step - the bowling ball (held in both hands) is pushed forward (not up) away from the body. Both arms are simply extended. This places the bowling ball in such a position that the pull of gravity can be very effective. The body should be <u>slightly</u> inclined forward.

b) On the second step - the arm with the bowling ball swings down and back. This arm swing is assisted by the pull of gravity if no resistance is offered. The arm with-out the bowling ball should move out and back in such a position that it may act as a counterbalancing force for the body.

c) On the third step - the bowling ball continues back. The backswing should reach about shoulder height, no higher.

d) The fourth step - is completed with a slide on the left foot with the knee bent and the body (still) slightly inclined forward (head also) which permits the gradual slowing of the body momentum.

At the beginning of the fourth step the bowling ball begins it's movement downward and forward. Again, a gravity propelled swing will produce adequate momentum if no resistance is offered. The bowling ball should be released at the beginning of the upswing. The release should be during the completion of the slide. After the release of the bowling ball the arm should continue it's original arc of movement (follow-through).

The right foot drags, either straight back or behind the left foot, in this manner it may act as a brake in addition to assisting in maintaining body balance.

2. Body Position --

Through-out the entire approach the toes should be pointed straight ahead and the body should be facing the pins with the shoulders parallel to the foul line.

The body is <u>slightly</u> inclined forward through-out the approach. This incline makes possible a greater backswing and offers counterbalance for the weight of the bowling ball as it is swung back at arms length.

The knee bend (or lowering of the body) during the fourth step increases the body balance by lowering the center of gravity of the body. The lower body position enables the bowler to place the bowling ball on the lane in such a manner that most of the application of force results in forward movement of the ball rather than downward.

The lowering of the body with a slight incline makes it possible to flatten the arc through which the bowling ball moves, this increases the accuracy of the pattern of movement.

It is important to realize that too much forward lean can cause difficulties in balancing the body. The bending of the knee should be emphasized rather than the forward lean.

C. Types of Deliveries --

1. Curve -- the bowling ball travels in a wide arc (horizontal plane) from the time it leaves the hand until it hits the pins. This type of delivery is not a desirable one because it is difficult to control and of the space necessary to accomidate the path of the bowling ball.

2. Back-up -- the bowling ball travels straight for a time then breaks to the right (right handed bowler) since the bowling ball has right spin on it.

This delivery is difficult to control because of the wrist turn involved. The fact that if pin fall is to be most effective the bowling ball should contact the pins from the left hand side of the head pin creates some difficulty for most right handed bowlers. It proves to be confusing to a beginner, to say the least.

3. Straight -- the bowling ball travels straight down the lane. This delivery is considered good for beginners because it does not involve wrist turn. The bowling ball is held with the thumb up, in a 12 o'clock position, with the fingers and palm of the hand under the ball. In this manner the hand is in a position to hold some of the weight of the bowling ball. Because the thumb is shorter than the fingers it slides out first and then the bowling ball rolls off the finger tips. During the follow-through the hand remains in this same position, thumb up (on top) with the palm of the hand up. A locked wrist is very important in this type of delivery other wise a back-up or hook delivery will result. In the straight delivery the angle at which the bowling ball contacts the pins is not the most effective angle.

4. Hook -- the ball travels straight for a time then breaks (turns) to the left(for a right handed bowler) since the bowling ball has left spin.

This type of delivery is considered the most desirable because when it is controlled it has a high strike percentage due to the angle at which it is able to contact the pins. This particular angle is impossible with the straight delivery. Since the pin contact is on the same side as the hand and arm delivering the bowling ball it creates less problems for the bowler when determining point of aim for spare pick-ups.

For the "natural hook", which is considered the best type of hook because it is more consistant than the others, the hand forms a V with the thumb and the first finger facing up (as in shaking hands). The thumb is in an 11 o'clock position and the first finger is in a 1 o'clock position, the wrist is firm and straight, simply forming an extension of the arm. The wrist remains firm(or fixed)through out the approach and the follow-through. There is no rotation of the wrist. Because the thumb is shorter than the fingers it should and will come out of the bowling ball first. As the fingers come out of the bowling ball a slight left spin is applied to the ball. If the bowler is relaxed and not attempting to consciously control or maneuver the bowling ball a "natural hook" will occur, the bowling ball will break slightly to the left just before striking the pins. Although the break will not be as great as with some of the other types of hooks it will be quite effective if it contacts the pins in the correct spot. The ability to relax will prove to be an important factor when executing the "natural hook".

5. Hints --

a) The weight of the ball should be in the shoulder not at the forearm or wrist. The arm should be kept straight and relaxed.

b) The wrist should be firm and straight.

c) The arm should swing like a pendulum. If it is relaxed and if all joints are firm (or fixed) this will be possible. Relaxing the arm will add to the ability to swing the arm in a pendulum fashion.

d) Allow the weight of the bowling ball to pull on the arm, primarily at the shoulder. This will help the bowler keep the arm straight.

e) The delivery should be made from the shoulder and straight forward from the shoulder. Get in the habit of "reaching for" the target after the release and during the follow-through.

f) Never throw the bowling ball, simply release it. If the approach has been executed correctly there is absolutely no reason (or advantage) in throwing the bowling ball.

If the approach has not been executed correctly then work on that, but do not attempt to compensate for errors in the approach by throwing the bowling ball.

D. Aiming --

1. Theories of Aiming --

a) Spot -- the bowler selects one of the dots between the foul line and the pins, over which he attempts to roll the bowling ball. Either the dots or arrows may be used. Once the target is determined it is simply a matter of adjusting the point of aim for spare pick-up.

The bowler should concentrate on (look at) the spot being used for aiming until the ball passes over (or by) the spot.

Spot bowling is very exact. The bowler must know his exact position on the line when starting the approach and he must also know the exact spot the bowling ball rolls over. It is simply a matter of adjusting the aim in order that the ball will contact the pins in such a manner as to knock them down. Once the bowler finds and remembers the correct point of aim for each set-up of pins the average will improve.

Spot bowling is considered best for beginners since the dots (or arrows) are a closer target than are the pins.

b) Pin -- On the first ball the bowler aims for the 5 pin or the 1-3 pocket(right hander). On the second ball the bowler aims directly at the pin or pins he intends to hit. This method of aiming is less accurate than spot bowling.

c) Line -- is a combination of spot and pin bowling. The bowler draws an imaginary line from the stance position to the strike pocket or the pins to be hit.

This is a precision method of aiming that requires great concentration and a lot of practice.

d) Check Points for All Three Methods of Aiming --

(1) Starting position.

(2) Slide position.

(3) Spot

(4) Strike pocket (pins to be picked up)

2. Spares --

A good bowler must be able to pick up spares and splits.

a) For a right handed bowler, when the 6, 10, or 6-10 pins are left standing the bowler should move to the left side of the approach, in order to be able to use as much of the alley width as possible. The bowler should walk diagonally toward the pins when executing the approach. This is the only time the bowler should move to the left of the approach.

b) When pins are left standing on the left of the alley there are two theories:

(1) The bowler moves to the right of his regular starting point and moves his point of aim to

the left.

(2) The bowler stays on his regular starting spot (strike spot) and moves only his point of aim. How much the point of aim is moved depends upon the setup of pins left standing. This method is the most consistant because there are fewer adjustments to be made.

3. Hints --

a) A good general rule in spare bowling is to aim the ball so that it will cover as many of the remaining pins as possible. There are a few exceptions to this but in general it is a good rule. As the bowler becomes more advanced he may concentrate on particular or unusual spare pick-ups or split pick-ups.

b) A wide angle of approach is also an important rule to follow in that it gives the bowler room to allow for action of the bowling ball and even slight mistakes.

c) It is very important that the bowler concentrate, to the extent that every thing else in the bowling establishment is ignored from the time he starts his approach until the follow-through is completed.

d) Do Not Throw the bowling ball, just release it.

e) A very small change in the angle of the body or arm swing will cause the bowler to miss his target.

(1) Face the pins.

(2) The shoulders should be parallel with the foul line.

(3) The arm swing should be natural, relaxed and straight(only in a vertical plane).

f) The advantage in spot bowling is that the target is closer to the bowler.

g) It is essential that the point of release be consistant.

h) The rebound action of the bowling ball and the pins must be considered in planning the exact target for both strikes and spares.

When one pin is directly behind another, the front pin must be hit squarely (full) if the pin behind is to be knocked down (cleared).

i) In spot bowling, the target must be very exact and must be hit squarely if the pins are to be hit in the desired place. Keep your eyes on the point of aim until the ball passes through the point.

j) A one pin spare is actually a 23 inch target.

k) If a bowler is thinking he should not make the same mistake three times.

l) Learn to relax.

m) Concentrate on every shot.

E. Release of the Bowling Ball --

1. The bowling ball should be released at the beginning

of the up-swing.

a) If the bowling ball is released too soon(before the beginning of the up-swing) the direction of the application of force is primarily downward rather than forward.

b) If the bowling ball is held too long during the release:

(1) It will be lofted.

(2) It will go off to the left for the right hander and to the right for the left hander.

2. The bowling ball should be placed on the lane slightly in front of the body and slightly to the right of the body for the right hander or slightly to the left of the body for the left hander. The arm swing should be a natural swing from the shoulder.

3. The swing-through (forward swing) of the arm should be executed when the body has it's maximum speed.

4. The slide of the last step and the swing-through of the arm should be simultaneous.

5. The bowling ball should have 3 motions if it is released correctly:

a) Slide or skid.

b) Roll or rotation.

c) Turn, caused by the application of spin(hook or back-up).

IX. PRINCIPLES --

A. Force --

1. For the average person maximum force is not necessary in bowling.
2. Enough force to knock down pins and to knock pins into other pins, effectively, is necessary - past this point - control is more important than force.
3. Since counterforce depends upon the momentum of the bowling ball it is possible to have too much force. Concentrating on the application of force often results in loss of control.
4. Force developed from a gravity propelled swing will be consistant.
   a) The bowling ball should not be thrown, it should simply be released. DO NOT THROW THE BOWLING BALL!
   b) Because a straight arm is longer than a bent arm the arc of the arm swing will be greater and consequently greater force will result with no conscious effort by the bowler.
5. The bowling ball must be placed in a position where gravity can act upon it most effectively.
   a) Push the bowling ball away from (out in front of) the body on the first step.
   b) It is necessary to have an adequate backswing, no more than shoulder high. If the backswing is higher than the shoulders, control is lost, too much force results.

6. Ways of increasing force or speed of the bowling ball:
   a) Hold the bowling ball higher in the starting position.
   b) Use more push away on the first step.
   c) Increase the height of the backswing.
   d) Perfect the timing or coordination of the various movements required in the approach.
7. The slight forward incline of the body during the approach will permit a higher backswing without deviating from a straight line (vertical plane).
8. Force can be increased by increasing the speed of the approach since momentum can be transferred. It is most important to realize that when the steps in the approach are executed in a shorter period of time:
   a) The steps must be smaller.
   b) The arm swing will also have to be executed in the same (shorter) period of time.
   c) It is important <u>not</u> to rush the foul line.
9. Top spin increases the speed of the bowling ball.
10. The arc of movement of the arm should be continued after the bowling ball is releases (follow-through) to allow for maximum application of force(developed from a gravity propelled swing) in the desired direction.

    The follow-through should continue until the arc is completed (or nearly so). Because the human body is incapable of abruptly stopping movement, it employs a slowing process, which must begin shortly after the start of the original movement, which would obviously reduce the amount of force applied to the original movement. If the arm is jerked or pulled in a direction other than that of it's original arc of movement the application of force will be, entirely or partially, in the new direction. This will of course change the direction in which the bowling ball will travel.

11. Control is more important than force.

B. Balance --

1. Through-out the bowling approach the body should be balanced above it's base of support (the feet and the distance between them). Since the body is constantly shifting a continuous effort to balance the body is necessary.
2. The free arm should swing to the side, up, and back away from the body if the weight of the bowling ball, held by the opposite hand and arm, is to be balanced.
3. The slight forward incline of the body helps to balance the weight of the bowling ball during the backswing.
4. Each step in the approach requires the same amount of time, but each step increases in length. Because more distance is covered in the same amount of time, there is acceleration from the first step through the

last. The first step will be shorter and slower than the other steps.

5. The coordination of the arm swing and the steps is a very important consideration. The time required for the arm swing depends upon the length of the arm. The longer the arm, the slower the steps must be in order to coordinate them with the arm swing.

C. Direction Control --

1. The backswing and the follow-through should be in a vertical plane and in line with the target.
2. If the arm swing involves a horizontal plane of movement it will interfere with the accuracy of the path of the bowling ball.
3. Top spin will not effect the direction in which the bowling ball moves but it will effect the speed at which it travels.
4. Side spin will effect the direction in which the bowling ball moves. If the bowling ball has received right spin it will cut to the right. If it has received left spin it will cut to the left. How soon the bowling ball will cut (or turn) depends upon the speed at which it is traveling. The faster it is moving the later it will break, that is, it will travel in a straight line for a time then as it gets close to the pins it will break (change direction).

Side spin will reduce the speed of an object, however, because the bowling ball is heavy and because it is rolling (not a projectile), side spin will have little effect upon the speed at which the bowling ball travels.

5. To develop a consistant hook the bowling ball must be released with the exact same amount of spin each time.

   The "natural hook" is considered the best type of hook because it is a natural movement and it does not require wrist turn. Since no wrist turn is involved the "natural hook" delivery(or release) is a consistant one. Because the thumb is shorter than the fingers, it will come out of the bowling ball first with the fingers following (if the bowler is relaxed and not attempting to throw or consciously control the bowling ball). This method of release creates slight left spin upon the ball which will cause the bowling ball to break slightly to the left.

6. If wrist turn is involved, it should be executed just before the bowling ball is released. A definite pattern should be established if wrist turn is employed. There are various patterns used:

   a) Start the arm movement with the thumb at 1 o'clock and maintain this hand position during the backswing and the swing-through until <u>just</u> before the moment of release, at this point rotate the wrist so that the thumb is at a 9 o'-

clock position.

b) Start the arm movement with the wrist rotated so that the thumb is at 12 o'clock and just before release, the wrist is rotated to a 7 o'clock position.

Again, when using wrist turn it is vitally important to establish a definite pattern so that the greatest possible consistancy can be developed.

If the wrist turn occurs too soon or too late it will have no effect upon the direction of the path of the bowling ball.

D. Rebound --

1. Because of the momentum (weight x speed) of the bowling ball it will experience very little rebound from the lighter stationary pins.

The slower the bowling ball is moving the greater rebound it will experience.

Rebound will be slight but it will be enough to cause errors if it is not considered when aiming.

2. The rebound of the stationary pins will be great and will depend upon the:

a) Momentum of the bowling ball.

b) Spin on the bowling ball.

c) Point at which the bowling ball contacts the pin or pins.

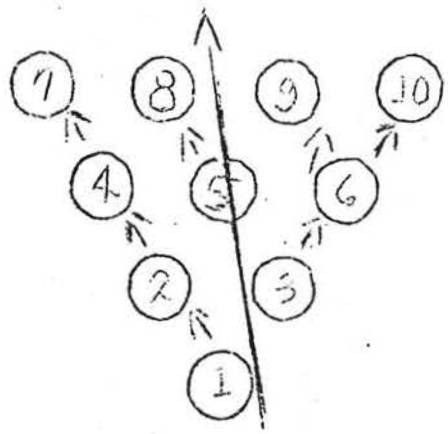
The rebound of the pins is a very important aspect of bowling. It is very important to understand how the pin(or pins)will rebound when contacted at various points.

A bowling ball with no spin will cause a pin to rebound at the same angle at which it was struck. With side spin the angle of rebound will change, it will not be at the exact same angle at which it was struck. The degree of spin will determine the amount of variation.

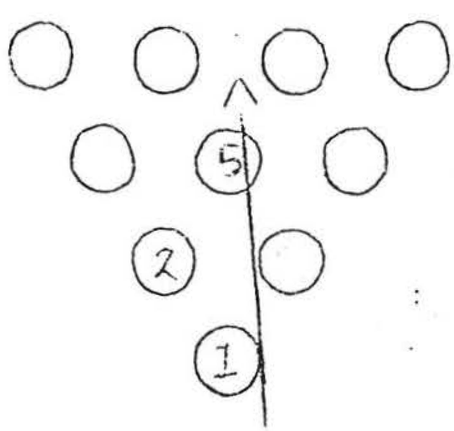
Friction proves to be an advantage when the bowling ball has side spin in that it results in greater pin action (rebounding a pin or pins into other pins at such an angle that the remaining pins are knocked down).

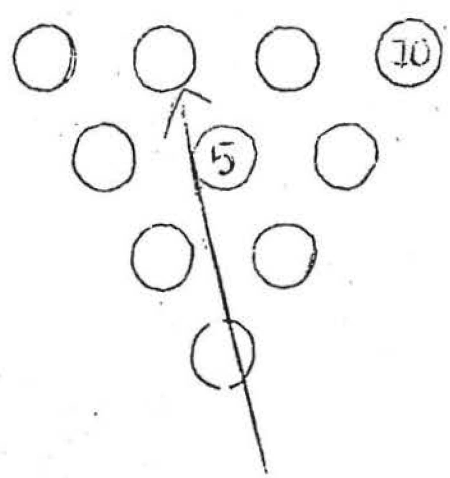
Example:

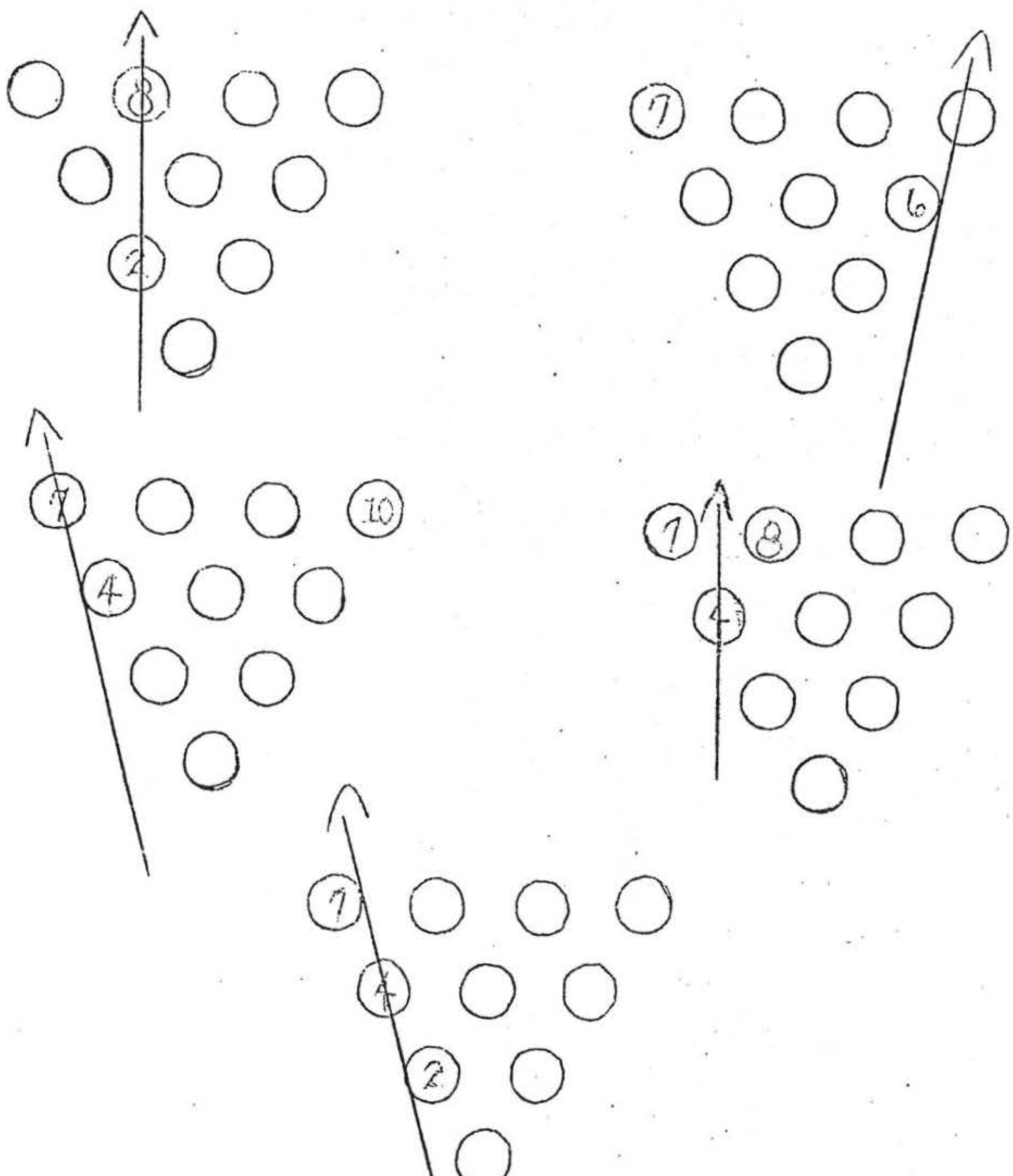
A bowling ball with left spin (hook) contacting the strike pocket (1-3 for right hander) will cause the 3 pin to spin right and rebound into the 6 pin and back toward the space between the 9 and 10 pins. The 6 pin rebounds into the 10 pin. The 1 pin will have left spin and will rebound back in the direction of the 7 pin, hitting the 2 pin which then hits the 4 pin which in turn hits the 7 pin. The bowling ball will continue its original path,with very little if any rebound, moving toward the 5 pin and between the 8 and 9 pins. Each pin that is hit will receive some spin and will in turn strike other pins sending them into still other pins. The 5 pin after being struck should knock down the 8 pin and the bowling ball will take out the 9 pin.



3. The rebound action that must be considered:
   a) Pin or pins from the bowling ball.
   b) Pins from pins.
   c) Very slight (if any) bowling ball from the pin or pins. The faster the ball is traveling the less the rebound.
   d) Pins from pit cushions.
4. Other rebound angles(in general):







THIS IS THE DIFFICULT PART OF BOWLING!

The ability to cause the bowling ball to contact the pin or pins at the exact spot which will cause them to rebound in the desired direction.

BOWLING TEACHING UNIT

The day before the class meets at the bowling lanes explain the:

1. Fact that it is extremely important that the students participating in the study do not practice until after the required twenty lines of bowling have been completed.
2. Team and lane assignments.
3. Procedures to be followed in conducting the class.
4. Procedures for obtaining bowling shoes.
5. Procedures to be followed when picking out a bowling ball that fits the students hand.
6. Procedures to be followed in making assignments and assign the fundamentals included in the mimeographed material which each student received at the first class meeting.

The first few days at the bowling lanes will be utalized by having each student walk through and practice the four step approach. One member from each team will be involved in the drill at one time. The following points are to be given major consideration and executed in this order during this primary drill:

Without the bowling ball --

1. Explain the starting position and the four step approach.
2. Have students assume the correct starting position.
3. Students execute four walking steps.
4. Students execute four walking steps with a slide on the fourth step, employing forward incline of the body with forward knee bent.

5. Teacher checking the position of the students at the foul line for:
   A. Distance from foul line.
   B. Facing pins (shoulders parallel to foul line).
   C. Forward knee bent.
   D. Body inclined forward.
   E. Path of approach.
6. Repeat, four steps with the slide, faster count by teacher.
7. Repeat several times, increasing the speed until it is at the proper rate.
8. Students check their own position at the foul line.
9. Repeat the four steps with the slide several more times, allowing the students to move at their own rate of speed (no counting).
10. Explain the coordination of arm and leg movements.
11. Have students practice the first step with the push-away several times with the teacher giving verbal instructions. Emphasize the importance of the push-away on the first step.
12. Add the second step during which both arms start back.
13. Practice the first and second steps together, slowly with the teacher counting. Practice without the teacher counting, moving at their own rate of speed.
14. Add the third and fourth steps, teacher counting slowly as students execute four steps and the slide. Do not break the third and fourth steps down unless it appears necessary, usually students will do better if these steps are taught as one part (or movement).
15. Allow students to practice the coordination of arm and leg movements at their own rate of speed, while the teacher is checking for mistakes, still carefully observing the body position at the foul line.

16. Explain spot bowling and designate the dot (or spot) to be used in aiming for the strike pocket.

17. Explain importance of the straight arm backswing and follow-through being in line with the point of aim.

    A. Importance of arm movement being in a vertical plane during backswing, swingthrough, and follow-through.

    B. Walk toward designated spot.

    C. Follow-through of hand should pass right through the designated spot and continue until it is above the head.

    D. Emphasize looking at the specific point of aim, walking toward the point of aim, and follow-through across the point of aim.

18. Allow the students to go through the complete approach several times at their own rate of speed with the teacher watching for and correcting mistakes.

With the bowling ball--

19. Explain the mechanics ofthe automatic pin setters, caution students to check the pins and pin setters before releasing the bowling ball, also explain the procedure to be followed in taking turns while bowling.

20. Explain the natural hook release, have the students assume this hand position in relation to the bowling ball, at which time the teacher checks the hand position of each student. After the hand position has been checked the student may begin practicing the entire approach with the bowling ball, during which time the teacher is observing and giving verbal cues and correcting mistakes.

21. After these students have had several minutes of practice a different group is brought to the approach, this process continues until all students have practiced the fundamentals under the direction of the teacher.

Such instruction in fundamentals may take several days, depending upon the number of students in class. At any rate this process continues until each student in class has had the designated instruction in the fundamentals of bowling.

The Next Class Session -- after the completion of the drill in fundamentals of bowling will include a review of fundamentals with an emphasis upon the following check points:

1. Starting position on the approach.
2. Coordination of arm and leg movements, particular emphasis being given to the push-away on the first step.
3. Body position at the foul line.
4. Counter-balancing force employed.
5. Point of aim which is hit.
6. Execution of the follow-through.
7. Path of the bowling ball and how it hits the pins.

At this point the teacher begins to give individual help and instruction to the students as they take turns bowling.

Class Session --

The following class session will include:

1. Explanation of etiquette to be followed concerning bowlers on adjacent lanes.
2. Emphasis on position at the foul line:
   A. Hold the forward incline and the lowering of the body position at the foul line.
   B. Stay long enough to see the bowling ball hit the pins.

3. Assign principles included in the mimeographed material.
4. Review of fundamentals.
5. Teacher giving individual help and instruction.

Class Session --

1. Explain about picking up spares. Starting position is moved only for 6,10,6-10 (right hander) or 4,7,4-7 (left hander. For all other set-ups of pins simply adjust the point of aim, working from the basic point of aim for the strike ball. Each student will take four attempts at the ten pin (right handers) or the seven pin (left handers). Students will be instructed in line bowling, to be used only with these extreme spare pick-ups.
2. Assign score keeping in the mimeographed material.
3. Review fundamentals.
4. Give individual instruction.

Class Session--

1. Give out programmed material to be completed and turned in at the next class session.
2. Review fundamentals, emphasizing needed points.
3. Skill tests in spare pick-ups. .
4. Give individual instruction.

Class Session --

1. Explain and demonstrate scorekeeping with the use of the telescore maching. Answer all questions and re-explain as much as necessary.
2. Assign two students from each team to keep score, one person to do most of the score keeping. Score keeping will continue from this point through-out the semester.

3. Review fundamentals, emphasizing needed points.

4. Give individual instruction.

Class Session --

1. Explain the types of mistakes made in score keeping and return the score sheets with corrections to the students who kept score.

2. Explain about alternating lanes and check to see that students are managing it properly.

3. Remind students that they are not to practice.

4. Assigh two different students to keep score.

5. Concentrate on fundamentals.

6. Review picking up spares, set up specific skill tests.

Class Session --

1. Explain the mistakes made in score keeping and return the score sheets to the students who recorded the scores.

2. Assign history and rules of bowling which are included in the mimeographed material.

3. Skill tests in spare pick-ups.

4. Individual instruction in bowling.

Class Session --

From this point on instruction will be almost entirely individualized. Group instruction will be given when it is indicated according to the needs of the class. Score keeping will continue as will alternating of lanes. High score and high average will be circulated each day along with individual talley sheets and individual learning curves.

Students will be helped and encouraged to recognize, understand, and correct the mistakes they are making. The teacher will continue to check the score sheets and return them,each class session, so that the students will be aware of the mistakes they are making. Skill tests of the various types of spare pick-ups will be continued as will periodic reviews of fundamentals.

BOWLING RATING SCALE

Sample Copy of Rating Scale Used by Judges' to Evaluate Subjects' Application of Movement Principles in Bowling.

1	PUSH AWAY ON THE FIRST STEP	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
2	FORWARD INCLINE OF BODY AND HEAD	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
3	COUNTERBALANCE EMPLOYED	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
4	BACKSWING AND SWING-THROUGH	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
5	FACING PINS THROUGHOUT APPROACH	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
6	BENDING OF FORWARD KNEE	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
7	RELEASE OF BOWLING BALL	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
8	FOLLOW-THROUGH	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
	TOTAL -																