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THE EFFECT OF TUITION UPON THE ACQUISITION OF A COMPLEX MOTOR SKILL

UNIVERSITY OF CINCINNATI

JUNE 19 44

I hereby recommend that the thesis prepared under my supervision by DOROTHY R. DAVIES

entitled THE EFFECT OF TUITION UPON THE ACQUISITION OF A COMPLEX MOTOR SKILL

be accepted as fulfilling this part of the requirements for the degree of DOCTOR OF EDUCATION

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Form 668—G. S. and T. C.—1M—6-41

THE EFFECT OF TUITION UPON THE ACQUISITION OF A COMPLEX MOTOR SKILL

A dissertation submitted to

The Graduate Faculty of the Teachers College
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

DOCTOR OF EDUCATION

1944

by

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B. S., University of Cincinnati, 1928
M. A., Columbia University, 1932

ACKNOWLEDGEMENT

The writer wishes to acknowledge indebtedness to Dr. Gordon Hendrickson for help in the formulation of the original problem, and for his counsel and guidance in the organization and preparation of this thesis.

The writer is also indebted to Dr. Helen L. Coops for her inspiration, and to Dr. Louis A. Pechstein and Dr. Carter V. Good for their criticisms of this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THE PROBLEM AND ITS BACKGROUND

The Problem

Major Purpose of the Experiment.- The major purpose of this investigation is to study tuition as a condition affecting learning. The investigation is restricted to an analysis of the process of learning a complex motor skill (archery) by two groups of women college students under conditions comparable except for the experimental variable of tuition. The members of one group were given regular and systematic instruction in the technique of archery, of the type commonly presented by teachers of this sport. The members of the second group practiced archery under the observation of the experimenter, but without instruction. It was assumed that the group given tuition would show greater improvement than the group learning without tuition. The interest of the study, however, centers in the process of learning under these two conditions, rather than in the level of attainment.

Specific Questions.- The data obtained from this study may shed some light upon the following questions:

1. What is the effect of tuition in archery upon those

aspects of learning represented in curves of learning?

a. In what respects are the characteristics of the learning curves similar or dissimilar for subjects systematically instructed in archery and for subjects learning archery without instruction?

b. What effect does systematic instruction in archery have upon the rate of learning and level of achievement?

2. How are the factors of intelligence, size, experience in physical education, and personality related to achievement in archery, for the two groups compared? Specifically, for each group:

a. What is the relationship between intelligence test scores and achievement in archery?

b. What are the relationships between measures of height and weight, and achievement in archery?

c. What is the relationship between previous physical education experience and achievement in archery?

d. What are the relationships between certain personality traits and achievement in archery?

3. How are fluctuations in the learning curves of individuals and groups learning archery related to the presence or absence of tuition? Specifically, for each group:

a. What is the direction of changes in score within

single practice periods?

b. What is the direction of changes in score between practice periods?

c. What changes occur in achievement following a week's cessation from practice?

d. What changes occur in achievement under the stimulation of competition in a tournament for beginning archers?

4. What light upon the process of learning archery in the presence or absence of tuition is shed by the introspective reports of subjects and by non-quantitative records of behavior kept by the experimenter and other trained observers? Specifically, for each group:

a. To what ideas do the learners attend during the successive practice periods?

b. What techniques of archery do they acquire during the various practice periods?

c. What stages appear in the course of learning archery?

d. What are the effects of observatic of other learners during practice?

e. What reasons do the learners give for their fluctuations in performance in archery?

Implications of the Problem

Educational Implications.- In education there has been much interest in the manner in which learning takes place, and in the conditions under which learning is advanced. In the classroom, children actively learn to solve problems. It is the teacher's duty to guide the children in acceptable work methods, and to prevent them from making errors. The teacher also tries to motivate the children to do better work.

Tuition is given in order to aid the students in learning. It is expected that students so assisted will progress more rapidly than those not given instruction. While this matter will be given attention in the present study, it is not the main interest of the investigator.

In laboratory studies of the effects of practice on learning a skill, experimenters have almost invariably set up rigid conditions for presentation of the learning problem and for stimulation of the subjects, and then left the subjects to their own devices. Teachers of skill do nothing of this sort. Instead, they demonstrate, analyze, and describe the correct process while drilling the students in methods of work which prevent errors.

Investigators have studied the effects of the amount of practice engaged in, the temporal distribution of practice, the loss in achievement without practice, and other similar conditions affecting learning. There have

been relatively few investigations which study tuition as a condition of learning, and the effect which this tuition has upon the process of learning. More knowledge on this subject is needed.

This investigation deals with tuition in archery. The instruction was given in a typical educational situation, not in a laboratory. The tuition given was of the sort that is given in other motor skills, namely, general instructions in technique, presented to the class in a sequential order. While students were practicing this technique, they were also given individual assistance by the instructor.

From the statements just made, it may be seen that the findings of this investigation are potentially significant for the whole field of instruction in motor skill. Although no claim is made that any conclusions reached for archery should or can be applied to other skills without verification for these other types of activity, this study should possess interest and prove suggestive both for the general psychology of skill and for many areas of instruction, especially in physical education.

Implications for Teachers of Archery.- In presenting a complex skill to beginners, it is customary to teach the form, or methods of practice, which experts claim to have found to be most successful. This insistence upon acquiring a certain technique may have various

effects upon the learner and the learning process. If teachers know more about the effects which tuition has on the efficiency of learning, they should be better able to direct their students.

In most skills, several different forms are taught by the various teachers. The form which is used by the majority of the outstanding performers in the skill, such as district and national champions, is usually preferred. This preferred form will be taught by the teachers as soon as knowledge regarding it is disseminated. There have been very few scientific investigations ascertaining the relative merits of one form as against another in archery. Information of this sort will be of great value to teachers of archery. The present study bears upon this problem, although not specifically devoted to a comparison of various forms.

On the other hand, the greatest value of this study for teachers of archery is more likely to be found in the light it may shed upon their problems of instruction. The detailed analysis of the objectively observable behavior and the subjectively reported mental processes of girls learning archery should be of direct assistance to teachers of this skill.

Literature Related to the Problem

Introduction.- The literature which was reviewed before undertaking this investigation included summaries and handbooks on psychology, recent textbooks on psychology, investigations involving motor learning, and investigations involving tuition and learning. The textbooks in archery were reviewed, as well as those investigations which involved this skill. From this review was selected the material which would have a bearing on this investigation. The following pages present a resume of (1) investigations and literature relating to the skill of archery, (2) investigations and literature relating to the form, fluctuations, and plateaus found in learning curves, and (3) investigations involving tuition in relation to motor learning.

Early Investigation Using Archery to Study Learning.- A pioneer experiment in which archery was used as a means of studying the acquisition of skill was reported in 1915 by K. S. Lashley. [1] This investigator studied the mechanism of habit formation. He used archery in order to

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[1] K. S. Lashley, "The Acquisition of Skill in Archery," Carnegie Institute, Department of Marine Biology Papers, Vol. VII, pp. 109-10. Washington, D. C.: Carnegie Institute of Washington, 1915.

avoid the complexity of language habits. Lashley used eight subjects who shot outdoors. There was no control of wind, weight of arrows, tightness of the bow string, or of temperature. The subjects were given verbal instructions in nocking, drawing, and loosing the arrows. They were told nothing of aim, point of aim, or body position. Each subject shot twelve arrows a day for thirty days. Progress was plotted for each of the subjects. The experimenter, who read books about archery, took part in the experiment. The graph plotting his improvement showed quite different progress from that made by the other subjects who had no training. This one man had greater initial success than did the others of the group. His final achievement was much greater, and his learning curve showed fewer fluctuations and losses in score than did those of the other subjects in the experiment.

It was thought at the beginning of the present investigation that the data collected from this one subject in Lashley's experiment might be indicative of the type of evidence that would be collected from a group of subjects all of whom were given tuition in archery. It was also surmised in the present investigation that the records of the group which practiced without tuition would be similar to the records of Lashley's seven subjects who had no instruction in archery technique. The findings reported

later in this study indicate that these assumptions were valid.

Achievement in Archery.- More recently, Hyde [2] investigated achievement in archery. This investigator instructed the subjects in the fundamentals of the skill for three weeks before recording their scores. The subjects who practiced in the morning were superior to those who practiced in the afternoon. This was attributed to the fact that both groups shot their arrows outside, and there was more breeze in the afternoon than in the morning. Hyde found no correlation existing between the mental ability and archery ability of the students. The subjects showed a slight positive correlation between height and score, as well as between weight and score. These subjects showed a steady progress in achievement throughout the practice periods.

Technique of Leading Archers.- A survey of the techniques employed by the leading archers in the United States and Canada has been made by Craft. [3] The purpose of this survey was to ascertain the points of technique common to the majority of the best archers. Craft summarized the

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[2] Edith Hyde, "The Measurement of Achievement in Archery," Journal of Educational Research, XXVII (May, 1934), 72-86.

[3] Dave and Cia Craft, The Teaching of Archery, pp. 66-73. New York: A. S. Barnes and Company, 1936.

findings in terms of method of aim, hold on the bow, anchor position, loose, breathing, and stance. In the main, the form used by the majority of these archers was that taught to the subjects of the present investigation. The details of this technique will be given in Chapter II.

Methods of Teaching Archery.- Various methods of teaching archery have been presented by several authors. Craft [4,5] has drawn up a detailed progression for teaching both beginners and advanced archers. Miller [6] outlined the technique used by many archery teachers in the country.

Analysis of Learning.- Bills, [7] in his textbook on experimental psychology, states as his opinion that most learning can be divided into two types: (1) perceptual motor learning, or the formation of habits of acts of skill, and (2) ideational learning or memory. He classifies studies of

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[4] Dave and Cia Craft, op. cit., pp. 37-66.

[5] Cia Craft, "Suggestions on Teaching Advanced Archery," Journal of Health and Physical Education, VII (May, 1936), 322-23, 352-55.

[6] Myrtle Miller, "Helps for Archery Instructors," Individual Sports Guide, pp. 36-39. Published for the National Section of Women's Athletics of the American Association for Health, Physical Education, and Recreation. New York: A. S. Barnes and Company, 1942-43.

[7] Arthur G. Bills, General Experimental Psychology, pp. 179-80. New York: Longmans, Green and Company, 1937.

human learning into three types: studies of functions in which motor learning predominates, studies of functions in which the intellectual element predominates, and studies of functions in which both motor and ideational factors are important. Archery, classified under these categories, would be considered as a function of the perceptual motor learning type. In learning archery, motor learning predominates.

In the textbook by McGeoch [8] on human learning, he differentiates learning in terms of the things learned, which he calls interchangeably materials or activities. He describes the materials by placing them in three categories: (1) verbal materials, (2) perceptual motor activities which he says may be called skills, and (3) activities which involve the grasping of relations. Archery, under this classification, is regarded as a perceptual motor activity or skill.

Theoretical Analysis of Motor Learning.- There are several views concerning the way ir which motor learning takes place. The interpretation put upon the learning of archery will vary with the theoretical position taken by the interpreter. For this reason, the various theories

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[8] John A. McGeoch, Psychology of Human Learning, pp. 6-14. New York: Longmans, Green and Company, 1942.

of motor learning will be mentioned.

Angell, [9] a functionalist, believes that sensations and ideas are employed in gaining motor skill. He states that the development of voluntary control waits upon the accidental occurrence of movements which catch the attention, whereupon by recalling the memory of kinesthetic sensations aroused, the movements can be repeated. Muscular movement cannot be anticipated until one knows what it feels like, and it cannot be learned until it has occurred in some accidental way.

Thorndike [10] and Gates [11] explain learning in terms of connections. Thorndike says that connection-forming of the common animal type occurs frequently in infancy, by the mere try, try again method. He believes that all learning is analytic and selective; that the factors or conditions of improvement are the strengthening or weakening of bonds. By the method of trial and error, one learns to eliminate useless motions and to concentrate on

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[9] James R. Angell, An Introduction to Psychology, pp. 228-30. New York: Henry Holt and Company, 1918.

[10] E. L. Thorndike, "The Psychology of Learning," Educational Psychology, Vol. II, pp. 17-187. New York: Teachers College, Columbia University, 1926.

[11] Arthur Gates, "Connectionism: Present Concepts and Interpretations," The Psychology of Learning, Chapter IV. Forty-first Yearbook of the National Society for the Study of Education, Part II. Bloomington, Illinois: Public School Publishing Company, 1942.

successful acts.

The Gestalt theory of learning, as developed by Wheeler and Perkins, [12] conceives of learning as a behavior pattern wherein every act is a configurational phenomenon. It is a response of the organism as a whole. The essence of learning is not repeating a performance, but making a new one. All motor learning is preceded by a period of delay when the subject is constructing a perceptual configuration of the act to be done. During this delay, the learner perceives the goal and the details included in attaining it. From this delay, insight emerges.

Hunter [13] believes there is no adequate evidence for the assumption of a peculiar insight factor. All learning is essentially of a kind, the modification of behavior as a result of repeated stimulation under specific conditions.

A more eclectic view of learning is taken by McGeoch. [14] He believes there is no clear evidence of a

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[12] R. H. Wheeler and F. T. Perkins, Principles of Mental Development, pp. 35-37. New York: Thomas Y. Crowell Company, 1932.

[13] Walter S. Hunter, "Learning: II. Experimental Studies in Learning," Foundations of Experimental Psychology, pp. 570-76. Edited by Carl Murchison. Worcester, Massachusetts: Clark University Press, 1929.

[14] John A. McGeoch, op. cit., pp. 526-27.

sharp dichotomy between trial and error and insight. Instead, he describes learning as a process by which trial and error and insight merge one into another in what appears to be a continuous series of events.

In the present study no one school of thought will be followed. Instead, an eclectic view of motor learning will be maintained, and the interpretations put upon the learning will be from this point of view.

Learning Curves.- In the present investigation, learning curves will be used extensively as a device for studying learning. Therefore, the following analysis and explanation review certain concepts concerning these curves.

A learning curve is a graphic device for plotting changes in behavior. [15] In most curves the scale units of the ordinate express equal units of achievement. The trials or some equal units of practice are plotted along the abscissae. A curve plotted for the entire practice period from its beginning until the attainment of the criterion represents the amount learned. [16]

Shapes of Learning Curves.- Experimenters have

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[15] Arthur G. Bills, op. cit., p. 194.

[16] John A. McGeoch, op. cit., p. 33.

found learning curves to have various forms. They may be negatively accelerated, positively accelerated, straight-lined, or S-shaped. Most learning curves for skill are negatively accelerated, and are characterized by a sharp initial rise and many fluctuations. Some show one or more plateaus. Psychologists have tried to explain the various forms of these curves, in order better to understand them. One of the questions which are constantly raised is whether or not the characteristics noted are inherent in the learning process.

The rapid initial rise found in a negatively accelerated curve has been explained in many ways. Angell [17] attributes it to the condition of excitement and pleasure which accompanies the early stages of skill. Book, [18] experimenting with acquiring skill in typewriting, laid the rapid initial gain to making progress along many different lines at once. Hunter [19] believes it to be due to the disappearance of harmful initial factors, and the acquiring of the easily established components of the final habit.

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[17] James R. Angell, op. cit., pp. 53-54.

[18] William F. Book, The Psychology of Skill, pp. 570-71. New York: The Gregg Publishing Company, 1925.

[19] Walter S. Hunter, op. cit., pp. 570-71.

Peterson, [20] experimenting with ball tossing, thought that this phenomenon might be due to the method of plotting the curves. Thorndike [21] explains the sharp initial rise as follows: "A unit of time early subtracts many bad, and adds many good, bonds of large value to the score, whereas later in the course of training, it results in laboriously polishing off some of the minor details of efficiency, the major bonds having already been formed."

Trow and Sears, [22] working on card sorting, found a positively accelerated curve. This they attributed to the fact that the nature of the task was such that the subjects started on a plateau, rather than at zero ability.

In Stroud's experiments on memory, [23] he found S-shaped curves which he thought were due to the serial order of the learning and to the complexity of the material.

Fluctuations in Learning Curves.- Jagged ir-

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[20] Joseph Peterson, "Limits of Learning by Trial and Error," Journal of Experimental Psychology, IX (February, 1926), 45-55.

[21] E. L. Thorndike, op. cit., p. 262.

[22] William C. Trow and Richard Sears, "A Learning Plateau Due to Conflicting Methods of Practice," Journal of Educational Psychology, XVIII (January, 1927), 43-47.

[23] J. B. Stroud, "Effects of Complexity of Material upon the Form of Learning Curves," American Journal of Psychology, XLIV (October, 1932), 721-33.

regularities are characteristic of all practice curves. [24] These fluctuations are explained by Angell as methods of trial and error, eliminating useless superfluous motions.[25] Batson, [26] working on ball tossing, decided that the fluctuations were due to the varying physical and mental condition of the subjects. Book, [27] from observational studies and introspective reports from his typewriting subjects, attributes them to variations in attention and effort, varying degrees of difficulty from paragraph to paragraph, and fatigue and hygienic conditions. Lashley, experimenting with archery in the open air, attributed the fluctuations noted in the learning curves of his subjects to many causes:[28] chance, effects of wind, tightness of bow, temperature, and fatigue. Thorndike [29] attributes such fluctuations to the methods of plotting curves, and to many

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[24] Robert S. Woodworth, Experimental Psychology, p. 164. New York: Henry Holt and Company, 1938.

[25] James R. Angell, op. cit., p. 54.

[26] William H. Batson, "The Acquisition of Skill," Psychological Monographs, No. 91. Vol. XXI, No. 3. Princeton, New Jersey: Psychological Review Company, 1916. Pp. 63.

[27] William F. Book, op. cit., pp. 210-11.

[28] K. S. Lashley, op. cit., pp. 109-10.

[29] E. L. Thorndike, op. cit., p. 293.

other causes such as fatigue and emotion.

When a number of curves obtained under similar experimental conditions are combined, the fluctuations come at different points for different subjects. In consequence, the combined curve approaches smoothness.

Plateaus in Learning Curves.- Occasionally in some practice curves, the fluctuations have a tendency to flatten out. This represents a relatively constant level of performance, or a long-continued deviation from the trend of the total curve. These deviations are called plateaus. Batson, [30] experimenting with different types of skill, concluded that there was no evidence to show that plateaus occur in the learning process where only a single association is found. He noticed that in ball tossing, where subjects could attend to the factors as a whole, there were no plateaus. On the other hand, in other experiments where factors had to be attended in succession, or where the subject gave his attention to the separate factors, plateaus were found. Angell [31] explains plateaus as points at which the nervous system had assimilated as many new pathways as

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[30] William H. Batson, op. cit., p. 89.

[31] James R. Angell, op. cit., pp. 234-35.

it was for the moment capable of receiving. Bills [32] explains the presence of plateaus in complex skills as due to the fact that, when one part of the complex problem is brought to perfection, the subject attacks some other aspect and a new learning curve is initiated.

Bryan and Harter, [33] in studying the curves for receiving and sending in telegraphy, developed a theory of hierarchy of habits to explain learning. These investigators said that learning a motor skill consists of acquiring habits of various ranks or orders. Bryan and Harter concluded that plateaus do not appear in a relatively simple process. The plateaus do appear when the habits of low order approach their maximum development, but are not yet sufficiently learned to leave the attention free for the higher order of habits.

Book [34] found plateaus when subjects shifted emphasis and put forth less effort. He also explained them as "break down" stages caused by excessive effort wrongly

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[32] Arthur G. Bills, op. cit., pp. 201-203.

[33] William L. Bryan and Noble Harter, "Studies in the Telegraphic Language: The Acquisition of a Hierarchy of Habits," Psychological Review, VI (July, 1899), 346-75.

[34] William F. Book, op. cit., pp. 121-22, 213-15.

applied. Hunter [35] attributes plateaus to difficulties in eliminating errors. Lashley [36] found them due to a conflict of habits. No improvement could occur until new work methods were hit upon. Smith [37] experimented with a complicated ring-ball game. When the subjects bounced balls at a target, or tossed them at a target, he found that plateaus appeared in the learning curves of all subjects. He classified plateaus according to two main types: (1) those inherent in the process, and caused by concentration on one component of the task, or interaction between two components, or oscillation between two components, and (2) those due to incidental causes, such as nervous or emotional strain, lack of concentration, noise, and weather. He found that, while plateaus existed in all complex acts, they were not characteristic of any particular stage in the acquisition of skill. He concluded that sixty per cent of the plateaus were the result of accidents, and forty per

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[35] Walter S. Hunter, op. cit., pp. 572-73.

[36] K. S. Lashley, op. cit., p. 117.

[37] M. Drury Smith, "Periods of Arrested Progress in the Acquisition of Skill," British Journal of Psychology, XXI (July-April, 1930-31), 1-28.

cent were inherent. Swift [38] attributed these delays partly to lack of effort and enthusiasm, partly to the failure of the experimenter to measure progress, and partly to the necessity for subjects to perfect certain responses before proceeding to a higher level of efficiency. Trow and Sears [39] found in card sorting that plateaus resulted from habit interference, and limits of usefulness of a poor method. Thorndike [40] found delays occurring due to lapses in attention and interest. He attributes them also to periods of practice in errors.

The characteristics of plateaus have almost all been found in curves plotted from periods of practice where learning has taken place unassisted by expert teachers. In discussing the curves that he found, Book [41] contends that plateaus can be eliminated by skillful teaching. Mursell [42]

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[38] Edgar J. Swift, "The Acquisition of Skill in Typewriting: A Contribution to the Psychology of Learning," Psychological Bulletin, I (August 15, 1904), 295-305.

[39] William C. Trow and Richard Sears, op. cit., p. 47.

[40] E. L. Thorndike, op. cit., pp. 262-92.

[41] William F. Book, op. cit., p. 220.

[42] James Mursell, The Psychology of School Music Teaching, p. 68. New York: Silver, Burdett and Company, 1931.

states, "Skilled teachers, familiar with psychological principles, can nearly always obviate serious plateaus and regressions in learning." Cozens, [43] giving instruction in track and field events, found that there were no plateaus in the curves he plotted.

In the experiment conducted by Hyde, [44] the subjects were taught for three weeks before records were kept. The subjects then shot four practice ends at each of the following distances: twenty yards, thirty yards, forty yards, and fifty yards. The subjects finished shooting their arrows at one distance before advancing to the next distance. The curves plotted from the records of these arrows were similar to practice curves. The subjects had more difficulty making adjustment from the thirty to the forty yard range than from twenty to thirty yards, or from forty to fifty yards, although the increase in distance was the same in each case. The author suggests that the lower scores made by the students at the forty yard range might correspond to a plateau in the learning process.

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[43] Frederick W. Cozens, "The Determination of the Efficiency of Group Learning under Different Incentive Conditions and Modes of Activity," American Physical Education Association Research Quarterly, IV (May, 1933), 50-62.

[44] Edith Hyde, op. cit., pp. 72-86.

Tuition.- Tuition, according to Bills, [45] can be given in four different ways: (1) by artificially preventing errors, (2) by putting the subjects through the correct act, (3) by demonstrating the correct act, and (4) by calling attention to the salient features of the problem situation and its solution through verbal directions and other means. When a teacher does any of these, or a combination of any of these, he is giving instruction.

In this present investigation, the students were assisted in their learning by various methods of tuition. For this reason, the major studies of earlier investigators who were interested in tuition and learning are reviewed in the following pages.

Effect of Tuition upon Human and Animal Maze Learning.- The maze is a frequently used instrument for studying learning. The effect of tuition during maze learning has been studied by Alonzo, Ludgate, Carr, Carr and Osbourn, Koch, and Wang. The results of these investigations are reported briefly in the following paragraphs.

Effect of Manual Guidance upon Human and Animal Maze Learning.- Alonzo and Ludgate studied the ef-

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[45] Arthur G. Bills, op. cit., p. 245.

fects of manual guidance. Alonzo [46] studied the effects of manual guidance upon rats in learning to run a maze. This experimenter, by holding a leash attached to the rat, led the animal through the maze. He found that this type of guidance was beneficial to most and harmful to only a few of his subjects. Ludgate [47] used manual guidance upon human subjects. In this type of guidance, the experimenter grasped the stylus below the point at which it was held by the subject and guided the subject's hand over the true path of the maze. Ludgate studied the effects of this type of guidance by using two different methods. One method prevented errors, and the other method corrected them. She found the prevention of errors was more effective than correction of errors.

Effect of Visual Guidance upon Human Maze Learning.- Carr, [48] studying the effects of visual guidance on

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[46] Agustin Alonzo, "The Influence of Manual Guidance upon Maze Learning," Journal of Comparative Psychology, VI (April, 1926), 143-58.

[47] Katherine Ludgate, "The Effects of Manual Guidance upon Maze Learning," Psychological Monographs, No. 148. Vol. XXXIII, No. 1. Princeton, New Jersey: Psychological Review Company, 1924. Pp. 65.

[48] Harvey Carr, "The Influence of Visual Guidance in Maze Learning," Journal of Experimental Psychology, IV (December, 1921), 399-407.

the ability of humans to trace a maze, found it a very effective method. He emphasized that guidance given at certain intervals was more effective than when it was given at other times. Carr and Osbourn, [49] in a later experiment, also found vision an effective method of guidance.

Effect of Mechanical Guidance upon Maze Learning.- Mechanical guidance was accomplished in the maze by blocking the entrances to the cul-de-sacs so that, for any desired number of runs, the subject could traverse the true path only. Koch [50] found this type of guidance was beneficial to both rats and humans.

Effect of Verbal Guidance upon Human Maze Learning.- Wang [51] studied the effects of two methods of verbal guidance. In one form, the experimenter told the subject which moves to make while traversing the maze. Wang called this procedure the method of instruction. In the method of

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[49] Harvey Carr and E. B. Osbourn, "The Influence of Vision in Acquiring Skill," Journal of Experimental Psychology, V (October, 1922), 301-11.

[50] H. L. Koch, "The Influence of Mechanical Guidance upon Maze Learning," Psychological Monographs, No. 197. Vol. XXXII, No. 5. Princeton, New Jersey: Psychological Review Company, 1923. Pp. 112.

[51] Tsu Lien Wang, "The Influence of Tuition in the Acquisition of Skill," Psychological Monographs, No. 154. Vol. XXXIV, No. 1. Princeton, New Jersey: Psychological Review Company, 1925. Pp. 81.

information, Wang gave a signal when the subject started to make an error, or different amounts of information were given about an error as soon as it was made. The method of instruction was found to be more efficacious than the method of information. The subjects to whom Wang gave instructions as they were in the process of traversing the maze learned more quickly than did the subjects to whom Wang signalled as they were about to commit an error.

Effect of Tuition upon Pursuit Learning.- The pursuitmeter has often been used as a means of studying motor learning. Renshaw and Postle [52] studied three methods of pursuit learning. Their findings were contrary to those of other investigators. The group to whom these experimenters gave tuition learned more slowly than the group who learned by practice alone.

Effect of Tuition in Teaching Complex Motor Skills.- Goodenough [53] conducted a learning experiment with pre-school children. She used three groups, the members of

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[52] Samuel Renshaw and Dorothy Postle, "Pursuit Learning under Three Types of Instruction," Journal of General Psychology, I (March, 1928), 360-67.

[53] Florence Goodenough and C. R. Brian, "Certain Factors Underlying the Acquisition of Motor Skill by Pre-School Children," Journal of Experimental Psychology, XII (April, 1929), 127-55.

which learned to throw rings over a peg. To one group, no instructions were given. To another, verbal comments, such as "not so far, next time," were made. The third group was made to adhere to one method of throwing, and was instructed in the technique. Goodenough concluded from this experiment, with children whose powers of self-criticism were undeveloped, that (1) uncontrolled practice is an uncertain method of acquiring skill, (2) verbal suggestions and criticisms are of small effectiveness in bringing about improvement, and (3) continued practice according to a constant method is more likely to result in improvement.

Cozens [54] studied the effects of tuition on group learning of track and field events. He found that improvement in any one skill was usually accompanied by improvement in skill in other track and field events. The learning curves he plotted were similar to those found in typing, telegraphy, and ball tossing. There were no plateaus in the curves. There was no evidence to show that observation of others assisted the subjects in their own efforts.

The curves Cozens plotted were based upon tests given at intervals, not upon each practice trial. The

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[54] Frederick W. Cozens, op. cit., pp. 50-62.

periods of no visible progress may, by chance, have taken place between test periods. This may have accounted for the fact that no plateaus were seen. This investigator also found that greater improvement than chance alone could account for took place in all six events in which he instructed the men. The best performance in all events, except the half-mile run and the low hurdles, took place at the end of the season. In the two exceptions, the peak of performance was reached about one third of the way through the semester.

The curves plotted for the dash and shotput showed a downward curve at the beginning of the experiment. This, Cozens attributed to emphasis placed upon technique during the early stages of learning those skills. No attempt was made to control weather conditions in this experiment on track and field events. The fluctuations which were seen in the curve were attributed as due to temperature. The losses in score occurred on cold, raw days.

Generalizations from the Literature.- From the foregoing review of literature, the following generalizations may be made. These are selected with special reference to their pertinence to the present investigation.

1. An eclectic point of view in the theories of learning has been taken by most of the recent

writers in psychology.

2. Tuition, given by any of several methods, has increased the performance of students over that of the uninstructed students in almost all cases.
3. There is practically no literature dealing with the comparison of learning curves for groups aided by tuition as against those not aided by tuition under classroom situations.

Summary

Chapter Summary.- The purpose of this study is to investigate the effects of tuition during practice upon the process of learning archery. There have been very few investigations of learning motor skills under tuition. A study such as this is needed by educators in order to shed more light upon the means by which students learn under the tutelage of instructors. Such a study should also be of direct help to teachers of archery.

There have been many studies of learning which are related to this investigation. Some of these studies involved the use of archery. The theoretical analysis of learning was reviewed as a necessary background to this study. Investigations involving the various aspects of the learning curve were surveyed for information which would

help interpret the findings. Background for the present study was also secured by reviewing the studies made in which subjects were assisted in practice by various types of tuition.

CHAPTER II

EXPERIMENTAL TECHNIQUE

Introduction

Chapter Outline.- This chapter first presents the general procedure and the setting for the experiment. It next describes the equipment that was used. Data are then presented on the subjects taking part in the investigation. Following this, a detailed account is provided of the procedure, including the instruction given throughout the experiment. The chapter concludes with a description of the methods used for scoring and tabulating results.

Archery as a Modern Sport.- Archery is the sport of shooting with a bow and arrow. It has had a long history, playing a part in hunting and warfare, and recently coming to be recognized as an appropriate activity in recreational programs. Within the last fifteen years, it has been introduced into many schools and colleges as a part of the regular physical education curriculum.

The bows used now are long bows of the English type, not the cross bows used by the American Indians. The bows and arrows employed vary in material, weight, and length. There are two standard sized target faces, of

which the larger is generally used for outdoor shooting, the smaller for many indoor rounds.

The National Archery Association sponsors collegiate, district, and national tournaments in the sport each year. This association has drawn up tournament rules which have been widely accepted by the archers of the United States.

Archers compete by shooting rounds of arrows at a target from different distances. There are many kinds of rounds, each of which is characterized by the number of arrows shot from a specified distance. In this investigation the round shot on tournament days was one-half a Range Round; [1] or thirty arrows shot from a distance of twenty yards at regulation outdoor targets.

General Procedure

Design of the Experiment.- The experimental procedure was designed to provide data on the learning of archery by two groups or classes; one, the experimental group, taught an accepted technique of archery; the other,

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[1] "Official Rules for Target Tournaments," Individual Sports Guide, p. 22. Published for the National Section of Women's Athletics of the American Association for Health, Physical Education, and Recreation. New York: A. S. Barnes and Company, 1942-43.

the control group, learning without instruction or assistance other than the minimum necessary for the manipulation of equipment with safety. [2] In general, it was desired that the two classes differ, so far as possible, only in the type and amount of instruction given them. Specifically, an attempt was made to keep the groups equal in the following respects:

(1) The students in the two groups were able to acquire skill in archery, so far as could be determined. (2) They had no previous experience in learning the technique needed to shoot a bow and arrow. (3) The groups practiced in a setting where they were not affected by variation in wind and weather. (4) Each group used the same type of equipment. (5) Each group had the same amount of practice. (6) The same instructor was present at each practice period. Detailed information on these points will be provided later in the present chapter.

To both groups the instructor explained the elements of the sport, how to handle the equipment, how to score, and the safety regulations. The experimental group was thereafter taught an accepted form for archery. The members of that group were given instruction in how to prevent errors and correct faults. The members of the control

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[2] The two groups of subjects are referred to in the present report either as experimental and control groups or tuition and non-tuition groups. The terms group and class are also used interchangeably.

group were not instructed in any specific form, but were allowed to shoot in any manner. Complete details describing exactly what instruction was given to each group will be given later in this chapter.

For the benefit of the reader unfamiliar with archery terminology, a list of terms used throughout this study is provided in the Appendix.

Setting and Equipment

Setting.- The experiment was conducted at Southern Illinois Normal University in Carbondale, Illinois, during March, April, and May, 1943. The subjects were women students of this institution.

The practice periods were conducted in a gymnasium where each group was free from interruptions. The subjects had no practice away from the gymnasium. The only archery equipment available to the students was that belonging to the physical education department, and this equipment was issued only during group practice periods.

Neither group ever saw the other group shoot. No pictures of archers were permitted to be posted in the school. All of the archery books in the library and book store were collected and kept out of circulation. No other archery was taught in Carbondale at the time of the experiment. The students, therefore, did not have the opportunity to see others shooting during the time they were practicing.

It was arbitrarily decided that the morning class be the experimental or tuition group, and the afternoon class be the control or non-tuition group. Figure 1 shows the gymnasium as arranged for the experiment. As will be shown subsequently, there is reason to believe that the members of the morning class gave no instruction or help to those in the afternoon class.

Shooting Distance.- A line was painted across the floor of the gymnasium twenty yards in front of the targets. The subjects straddled this line, and all arrows were shot from this distance. The line is not visible in Figure 1, but may be seen in Figure 11 (page 159).

Target Faces.- Three target faces were used. These were made of oilcloth, and were of regulation size and style for the Range Round. They were forty-eight inches in diameter and were painted with five colors. The colors were in five concentric circles, and the hits were designated by color when speaking of them. New faces were used whenever the old ones began to show signs of tearing.

One of these target faces is represented in Figure 2. The inner circle, painted gold, is 9.6 inches in diameter. The next colored circle is red. Outside of the red is the blue circle, and beyond it is the black one. The outer circle is painted white. Each of these four outer bands of color is 4.8 inches wide.

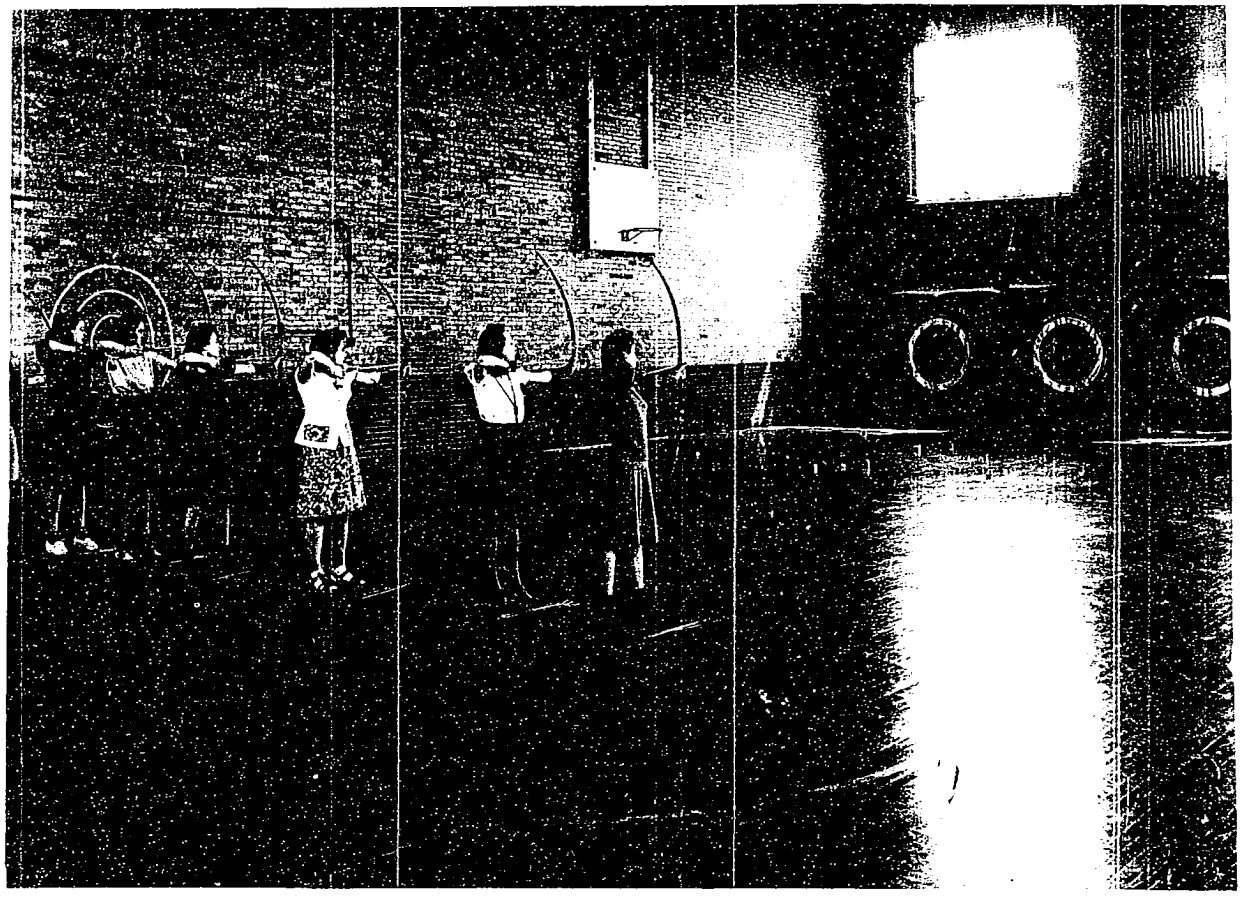


Figure 1.- Arrangement of gymnasium of Southern Illinois Normal University for the experiment on learning archery during March, April, and May, 1943.

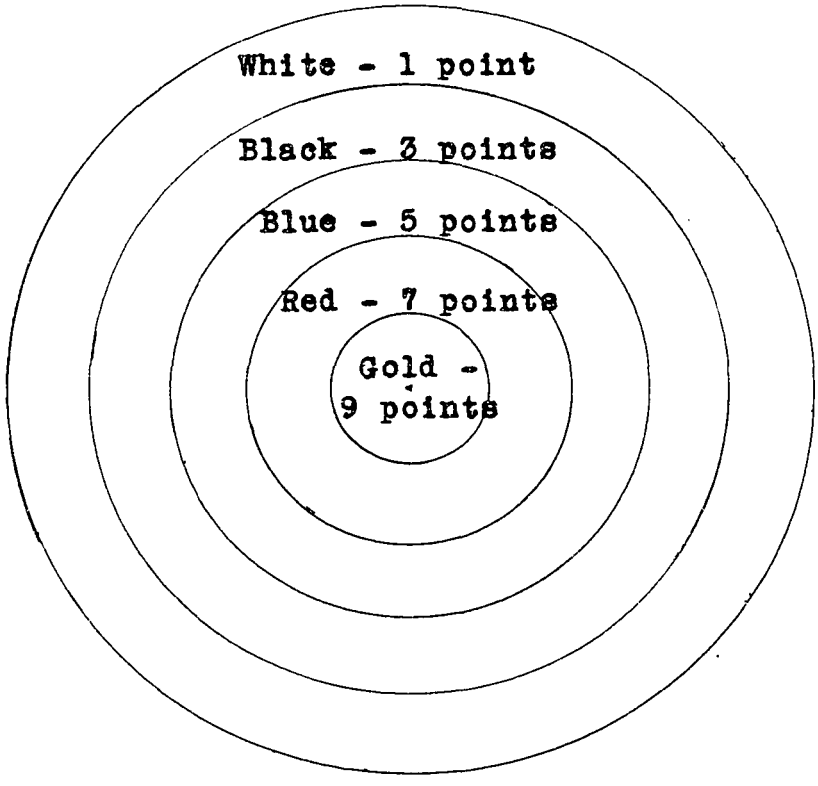


Figure 2.- Plan of target face used in experiment on learning archery.

These target faces were mounted so that the centers were four feet from the floor. Each face was mounted on a burlap covered straw backstop.

In keeping with standard archery rules, point values were assigned to the various circles, as shown in Figure 2.

Backstops.- Three backstops were constructed to catch the arrows which failed to hit the target faces. The framework was made of wood. Figure 3 is a photograph of this framework. Figures 4 and 5 show details of its construction.

The framework of each backstop was made as follows. A floor was constructed of two 1" by 9" boards ninety-two inches long. These were nailed across three 2" by 4" boards which were spaced to support the floor. The 2" by 4" pieces were thirty-two inches long, and extended from the front to the rear of the backstop. A back was constructed ninety-two inches wide and ninety-two inches long as follows. Two 2" by 4" uprights were placed on edge fifty-six inches apart. Across these were nailed three 1" by 12" boards and two 1" by 6" boards as shown in the diagram. This back was then nailed, at a slight angle to the floor, to the back of the two nine inch floor boards. The back was firmly braced to the floor by six wooden strips 7/8" by 4". One of these strips was

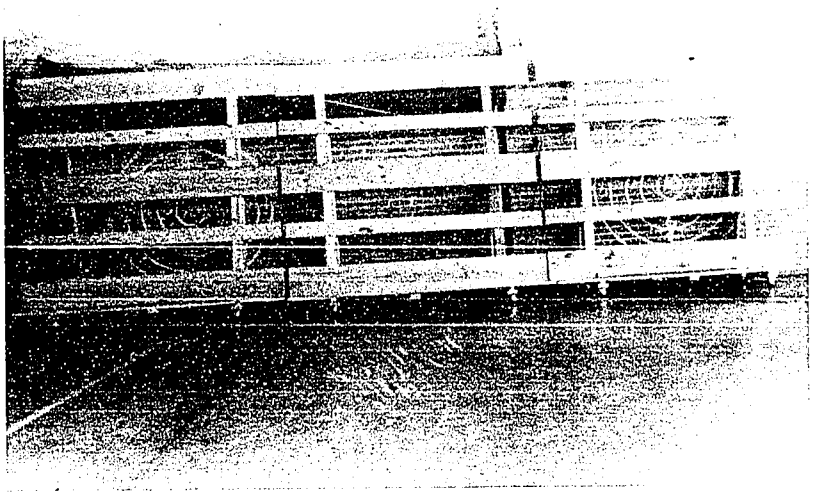


Figure 3.- Photograph of the front view of the archery backstops used in the experiment on learning archery.

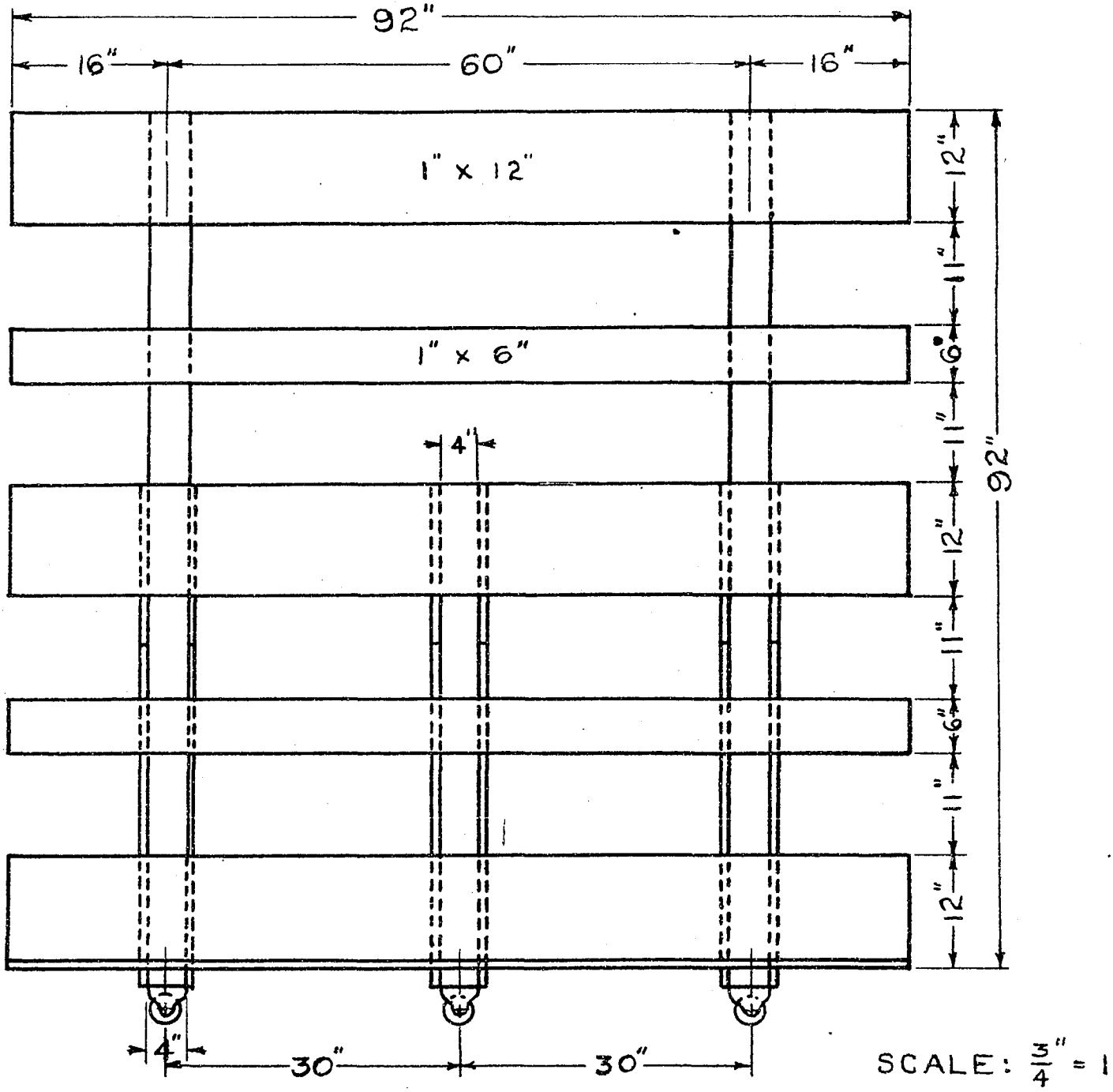
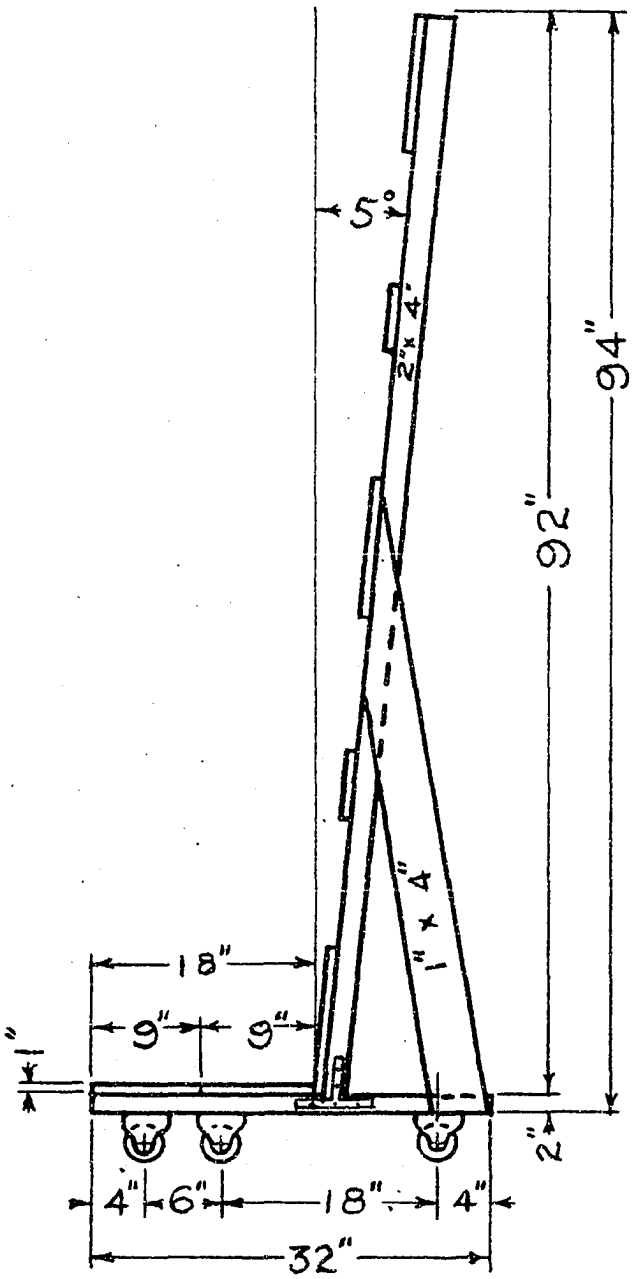


Figure 4.- Diagram of front view of one of the archery backstops used in experiment on learning archery.



SCALE: $\frac{3}{4}$" = 1'

Figure 5.- Diagram of side view of one of the archery backstops used in experiment on learning archery.

nailed on each side of the 2" by 4" boards of the floor. The strips extended diagonally from about the center of the back to the rear of the 2" by 4" floor supports. Where the back rested on the floor, angle irons were fastened to hold the back in place.

Five rubber-tired rollers were fastened to the floor supports, one at each end of the 2" by 4" boards and the fifth in the center of the middle 2" by 4" board.

On each backstop were piled ten bales of straw. Two bales were placed on the floor edgewise with the end of one next to the end of the other. Four more bales were placed one above the other on each of the bales on the floor. This made the backstop five bales high. The bales were bound to the framework with wire attached to the baling wire. Any chinks between bales were stuffed with newspaper. Burlap feed bags were ripped apart and sewed together to make a covering. This cover was pulled tight over the straw to keep the straw intact.

Since rollers had been placed under the backstops, some provision had to be made to catch the arrows which might fly underneath the target. A heavy denim apron was tacked to the floor of the backstop and extended forward on the floor of the gymnasium for several feet. This was effective in keeping the arrows in front of the backstops.

Individual Equipment.- Each girl had assigned to her a bow, arrows, armguard, and finger tab. The bows used were of lemonwood with a pull of from eighteen to twenty-five pounds. These were checked before each shooting period to see that the string was the required six inches from the belly of the bow.

The arrows were self arrows made of Port Orford cedar, and were from twenty-four to twenty-eight inches long. They were marked in nines, each nine bearing the same crest. Since only six arrows were shot at any one time, there were three extra arrows of each set to allow for replacement for breakage.

Leather finger tabs and arm guards were worn by all students to protect their fingers and arms.

Subjects

Subjects.- The subjects of this experiment were forty women students. The students were those who chose archery from among a group of physical activities offered for credit by the physical education department. None of the women had ever shot a bow and arrow before, except the cross bows some of them had made from branches of trees when they were children.

Two classes in archery were offered, one in the morning and one in the afternoon, each carrying one credit

point toward graduation. Twenty-three students signed up for the morning class, and twenty-three for the afternoon class. During the twenty-four class periods of the term six students withdrew from the experiment because of absences, leaving twenty students in each class. Records were kept of all class members, but only those are included here who had consistent attendance throughout the experiment, and were to every extent representative of the group. The two classes met each Tuesday and Thursday for fifty minutes. The experiment was carried on from March 9, 1943, to May 27, 1943.

Group Comparisons.- Although no attempt was made to match individuals with each other, the evidence shows that the classes were highly similar in terms of the variables considered. Data were secured on the height, weight, and previous physical education experience of each subject. The Otis Self-Administering Tests of Mental Ability, Higher Examination, Form B, were given to all subjects at the first class meeting.

The factors mentioned were chosen because they might influence learning. Hyde's study [3] showed slight positive correlations between height and archery ability,

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[3] Edith Hyde, "The Measurement of Achievement in Archery," Journal of Educational Research, XXVII (May, 1934), 72-86.

and weight and archery ability. The mental ability of the students would probably influence their ability to gain from tuition. Since ability to handle athletic equipment might be influenced by previous physical education experience, this factor was considered.

The group comparisons are shown in Tables I-IV. In general, these tables show similar central tendencies and variability for the two groups in each of the factors for which data were collected. In each case, the difference between the means is small, in comparison with the variability of each group. To be regarded as statistically significant, the difference between two means should be at least three times as large as its standard error. In all four tables, the critical ratio (difference divided by its standard deviation) is well under this figure.

The difference in mental ability scores is insignificant, since the ratio of the difference to its standard error is only .25, far less than the ratio of 3.00 required for practical certainty that the obtained difference is in the true direction.

The differences in height, weight, and previous physical education experience are also insignificant, since the significant ratio of these differences is considerably less than 3.00.

The differences that did exist between the two

TABLE I

DATA ON MENTAL TEST SCORES OF TWO GROUPS IN AN EXPERIMENT ON LEARNING ARCHERY

	Tuition Group	Non-tuition Group	Difference
Mean	52.25	53.00	0.75
Standard Deviation	8.60	9.96	1.36
Number of Cases	20.00	20.00	0.00
Standard Deviation of the Difference	2.93		
Critical Ratio	0.25		

TABLE II

DATA ON HEIGHT IN INCHES OF TWO ARCHERY GROUPS IN AN EXPERIMENT ON LEARNING ARCHERY

	Tuition Group	Non-tuition Group	Difference
Mean	63.02	63.52	0.50
Standard Deviation	2.88	1.81	1.07
Number of Cases	20.00	20.00	0.00
Standard Deviation of the Difference	0.75		
Critical Ratio	0.66		

TABLE III

DATA ON WEIGHT IN POUNDS OF TWO ARCHERY GROUPS IN AN EXPERIMENT ON LEARNING ARCHERY

	Tuition Group	Non-tuition Group	Difference
Mean	120.13	123.27	3.14
Standard Deviation	16.60	21.20	4.60
Number of Cases	20.00	20.00	0.00
Standard Deviation of the Difference	6.01		
Critical Ratio	0.52		

TABLE IV

DATA ON YEARS OF PREVIOUS PHYSICAL EDUCATION EXPERIENCE OF TWO ARCHERY GROUPS IN AN EXPERIMENT ON LEARNING ARCHERY

	Tuition Group	Non-tuition Group	Difference
Mean	4.36	4.21	0.15
Standard Deviation	2.11	2.49	0.38
Number of Cases	20.00	20.00	0.00
Standard Deviation of the Difference	0.72		
Critical Ratio	0.20		

groups seem unlikely to have had any material effect upon the work in archery which each class did. Most of the advantage that might have been attributed to the factors involved was in favor of the non-tuition group. These girls showed, on the average, slightly higher mental test scores, greater height, and heavier weight, but had fewer years of experience in physical education activities previous to this investigation than had the members of the tuition group. In the judgment of the experimenter, the two groups were highly similar to the other classes in archery which had been taught the skill in previous seasons.

Procedure

Method of Shooting.- Twenty subjects in each group completed the experiment. The girls in each class shot in three practice groups of six or seven each. When one group had finished shooting, the next group went to the shooting line for its turn (Figure 1). The extra girls shot as soon as the last group had finished. When all subjects had shot, all went to the target to recover their arrows.

Beginning of the Experiment.- At the first meeting of each class, the Otis Self-Administering Tests of Mental Ability, Higher Examination, Form B, were given.

During this period, routine school procedures, such as assignment of lockers and signing class cards, were completed.

At the second class meeting, the students filled in printed blanks telling of their past experience in physical education. (See Appendix.) The classes were told they were to take part in an experiment. The general purpose and procedure were made clear to the subjects. For the detailed statement of the description of the experiment which was explained to the class, see Appendix. The students were asked to cooperate and to give as much assistance as possible to the instructor conducting the experiment. They were asked to refrain from talking about archery technique with members of the other group, or with others who had had experience in shooting. They were asked to write introspective accounts of their learning. They were also asked to report whenever they received help from outside sources, if this should ever occur.

On this same day, the instructor brought a target face to class, and explained the scoring. Each student was given an individual score card and practiced scoring as the instructor pointed to the sections of the target face.

The students were measured for arrows. They were shown the crest and told how to distinguish their arrows from those of others in the same class.

At the third meeting of the class, each student

was assigned her own archery equipment. She was shown where to get this equipment at the beginning of the class, and how to replace it at the end of the period. The students were taught to brace and unbrace the bow. Up to this time, the two classes were treated exactly alike.

From this time on, the treatment given to the two classes was different. The tuition group was instructed in a specific technique of shooting. The group members were given all possible assistance to help them acquire the skill. The subjects were prevented from committing certain errors, and were given individual instruction to correct errors already committed.

The non-tuition group was given no assistance or instruction in any single method of shooting. The members learned by trying out their own ideas. They shot in any manner that suited the individuals.

Introspective Reports.- The students in both groups were asked to write down, immediately after each class, an introspective account of their mental content ("what went through their minds") while they were shooting. These reports were continued for the first ten practice days. Following that time, the students said that the reports were becoming mere reiterations of what they had previously said. The daily introspective accounts were discontinued thereafter.

Interviews.- Outside of class time, interviews were held with each girl. During these conferences, the students were encouraged to discuss their learning process. They were questioned regarding their progress, reactions to tuition or lack of tuition, and their methods of learning. Written records were kept of these conferences. See the Appendix for the outline of questions asked in the interviews.

Questionnaires.- Twice during the experiment, the students were asked to fill in questionnaires which were designed to aid in interpreting the learning process (see Appendix for questionnaires). The Personality Inventory, made by Robert Bernreuter, was given to each student on March 25.

Photographs.- Photographs of the individuals in each group were taken on the fifth shooting day, and again on the eighteenth shooting day.

Recording of Procedures.- In each class an observer was present to write down proceedings. The observers were students who had been taught archery in a former class taught by the instructor. Each of these observers knew the technique which was to be taught to the tuition group, and knew the errors commonly committed by the students learning archery, and the corrections for these errors.

The recorder in the experimental group wrote down all the group instruction that was given, the individual corrections the instructor gave, and the faults noted among the various students. She also wrote down any conversation between students which might aid in interpreting the learning process.

The observer in the control group kept a record of the changes in technique made by each student. She recorded conversation among students, and any discussions regarding differences in technique which were held between class members. For a sample of the reports of the observer, see the Appendix.

Instructions Given to Subjects

Instructions Given to the Non-tuition Group.- During the third meeting of the class, the members of the non-tuition group were each given a bow, and shown which was the correct limb to hold upright. They were told to grasp the handle of the bow in their left hands (right-handed archers). They were told to rotate their left elbows outward in order to keep the string of the bow from hitting their arms. This was practiced. The instructor gave manual assistance as well as verbal instruction in how to keep this arm turned. These instructions were thought to be necessary to prevent the students from bruis-

ing their arms. Also, if students hurt themselves while learning to shoot, they often lose interest in the sport. It was one of the aims of the instructor to keep all students interested in the sport while trying to improve their scores.

The students were told to put their left sides toward the target and to draw the bow string back with the right hand. They were told how to nock the arrow so that the cock feather was away from the bow. This was done in order to prevent them from ruining the arrows.

The subjects in this group were told to release their arrows by taking the right hand off the string (right-handed archers). They were cautioned against overdrawing the arrow. For the sake of safety, throughout the experiment the instructor stopped any student who started to overdraw, and corrected this error.

The members of this group were told to aim wherever they wished in order to hit the target.

No demonstration was ever given to this group. No assistance was given other than encouragement to keep the members trying.

Form Taught to the Tuition Group.- The descriptive statements in the following list comprise an analysis of the form taught to the members of the tuition group. They apply to right-handed archers, and the terms right and

left must be transposed in the case of a left-handed archer. Most of the parts of this form are demonstrated in Figures 6 and 7. Because these figures show only the upper part of the body, the stance cannot be seen. For a picture of the stance see Figure 1.

Stance
- left side to the target
- feet parallel
- feet together or apart as is comfortable
- body relaxed
- weight equally distributed on both feet

Left hand
- bow held at top of handle
- all fingers around bow, but only index finger and thumb actually hold the bow
- grip on bow as light as possible
- knuckles of index fingers flattened for an arrow rest
- bow rests in heel of hand

Left arm and shoulder
- wrist in normal alignment with the hand
- elbow and forearm rotated outward
- shoulder relaxed
- arm held straight out from shoulder

Right hand
- fingers on string opposite bow handle
- string pulled with first three fingers only
- pads of the fingers, only, touching the string
- hand straightened so that only first knuckles are bent

Right arm and shoulder
- elbow on a level with, or slightly higher than the shoulder
- elbow pulled back as far as possible

Head
- turned to the left
- look at target over left shoulder
- close left eye for aiming (if this is impossible, keep both eyes open)

Figure 6.- Form of the draw taught to the tuition group in experiment on learning archery.

Figure 7.- Form of the release taught to the tuition group in experiment on learning archery.

Position of anchorage
right hand pulled back until chin rests upon top of forefinger
string touched the middle of the chin
nose placed on the string

Release
string continued to be pulled back until it is pressed off the fingers by contact with the nose
right hand continued in backward motion until it comes to rest at right side of neck

Method of Aiming
point of aim method utilized

Progression in Teaching

General Progression.- During the first few weeks of practice in archery, much of the class time was devoted to group instruction in technique. After the students had acquired the ability to handle the equipment and to shoot in an approximation of the form taught, the possible errors they might make were presented and the manner of their prevention stressed. During the last few weeks of practice, individual correction of form was emphasized. Table V presents the dates of the practice periods and the main points of instruction given on those days.

First Week of Instruction to Tuition Group.- On March 16, at the third meeting of the tuition class, the students were told and shown how to stand, how to hold the bows, how to place the right hand on the string, and how to

TABLE V

DATA ON DAYS OF PRACTICE AND INSTRUCTION GIVEN TO TUITION GROUP IN AN EXPERIMENT ON LEARNING ARCHERY DURING MARCH, APRIL, AND MAY, 1943

Date	Day of Practice	Instruction Given
March 16	First	Nocking, holding bow, stance, and draw
March 18	Second	Release, sighting and aiming
March 23	Third	Body position, aiming, reasons for the arrow slipping off bow hand
March 30	Fourth	Individual correction
April 1	Fifth	None unless asked for by the student
April 6	Sixth	Lively release, reasons for the arrow flying high, writing down point of aim
April 8	Seventh	Anchor position and release
April 13	Eighth	Various types of releases with advantages and disadvantages of each
April 15	Ninth	Photographs of outstanding archers, and grouping of arrows

TABLE V (Continued)

Date	Day of Practice	Instruction Given
April 20	Tenth	None unless asked for by the student
April 29	Eleventh	Archery photographs of group members
May 4	Twelfth	Checking bow string for correct stringing, checking each arrow
May 6	Thirteenth	Aim, reasons for arrows going to the left
May 11	Fourteenth	Reasons for arrows going low
May 13	Fifteenth	None unless asked for by the student
May 18	Sixteenth	Individual correction
May 20	Seventeenth	Individual correction
May 25	Eighteenth	Individual correction
May 27	Nineteenth	None unless asked for by the student

draw. These details were demonstrated to them. While each practiced, the instructor went around the class giving manual assistance, or verbal correction in the pull and in body position. Emphasis was placed on keeping the left shoulder relaxed. The correct anchor position was emphasized. The instructor gave individual assistance to each girl in order that the student might attain the correct anchor position and body posture.

On this day, the students were also told how to nock the arrows. This procedure was demonstrated to them, and they practiced nocking arrows.

On March 18, the class reviewed the technique presented during the previous period. The group members were taught to release the arrow by opening the fingers and letting the string roll off. No instruction in final form of the release was given at this time. Blocks were put down for points of aim, and this method of aiming was explained. The subjects were taught to aim by sighting the block over the pile of the arrow.

Each student was assisted by the instructor when she shot her first arrows. This assistance was sometimes manual aid, intended to force the student into the correct position. The instructor held the bow arm and the right shoulder of the student in position. For some students this seemed to help very much. Often, only verbal assist-

ance was given. Two ends of arrows were shot by each girl on this day.

Second and Third Weeks of Instruction to Tuition Group.- On March 23, instruction was given on the assumption of the correct body position. The instructor demonstrated, as an example of faulty posture, a position in which the archer leans backward with the upper part of the body. She called attention to the error resulting from leaning in such a fashion. That the weight should be held on both feet was stressed. Individual correction was given throughout the shooting of the arrows.

The instructor explained the causes of the arrow falling off the left hand. This difficulty, she said, may be caused by pinching the arrow too much with the right hand, by placing right thumb on the arrow, by failing to have a flat knuckle of the left index finger, or by pulling the string away from the body as the bow is drawn.

Further instructions on point of aim were given. The students were told how to move their blocks up or back as was necessary. Individuals were assisted with this. Each girl shot three ends of arrows.

On March 30, individual correction was given to the class members. The technique, presented up to this time, was practiced while they shot three ends of arrows.

On April 1, the first tournament was held. No

group instruction was given. If any girl came to the instructor and asked for assistance in her shooting, or asked that she be corrected, she was given help. Each girl shot five ends of arrows.

Instructions Given to Tuition Group between First and Second Tournament Days.- On April 6, the instructor explained and demonstrated the lively release. The students practiced this. Each subject was given individual correction on this procedure, as needed. The error of plucking was demonstrated and the resultant deviation of the arrow explained. The reasons that the arrow goes high were explained, and the causes demonstrated. The reasons given were: poor aim, nocking the arrow crooked, dropping the right elbow, drawing so that right hand is below the chin, bending bow arm upward as the arrow is released, looking up before arrow hits the target, and leaning backward as arrow is shot. The students were taught how to write down their point of aim. Each did this with the assistance of the instructor. Each girl brought the written record of her point of aim to class with her on each subsequent practice period. Five ends of arrows were shot by each girl on this day.

On April 8, the group members were drilled on the correct release. Their anchor position as well as their release needed constant correction. The whole

period was given over to shooting and mechanizing the release and anchor position. Five ends were shot by each subject.

On April 13 the instructor demonstrated the various types of releases. The advantages and disadvantages of the releases were explained as follows: the creeping release causes the arrow to slow up and fall low. The dead release gives no "pep" to the arrow, and the archer has difficulty in making the arrow reach the target at long distances. The slashing release gives the arrow considerable impetus, but is difficult to perform without plucking. The lively release is the best to use for all-around archery purposes, because it gives a little impetus to the arrow without causing it to fly off its course of direction.

On this day all the group members drew marks on the floor to indicate their exact foot positions. The instructor insisted that they return to the same spot after they moved to collect their arrows. Individual correction was given in all shooting techniques. Five ends of arrows were shot by each.

On April 15 a photograph of an internationally famous archer was brought to class. The instructor pointed out each detail of his form, and the students studied the picture.

Grouping of arrows was discussed on this day.

Students were shown that the ability to group arrows was an indication of consistent form and good shooting, even though the arrows were not grouped in the center of the target. The instructor gave individual instructions to the students as they shot their arrows. Six ends were shot by each girl.

Instructions Given to the Tuition Group from the Second to the Third Tournament Days.- April 20 was a second tournament day. As in all tournaments, the instruction given was only that asked for by the individual student. Five ends were shot by each girl.

On April 29, the photographs taken of the students in the group were brought to the class. These photographs, which were taken on the first tournament day, showed the errors of various group members. These errors were pointed out and discussed. The instructor had other pictures of national archery champions at the class meeting. These pictures were compared and contrasted with those of the subjects taking part in this experiment. While the students shot, the instructor gave individual corrections. Each girl shot five ends of arrows.

On May 4, the students were taught how to check their bows to see that the string was the required distance from the belly of the bow. The instructor checked each bow before each class period. The students were taught to check their own bows during practice. They were

also taught to watch their bow strings and report any which looked as though they might break. They were also taught to watch their misses, and to check the arrows which went astray. Each arrow had a number on it, and if an arrow went off the target consistently, it was probably a poorer arrow. The students were taught to watch for any indication that an arrow was imperfect, and told to get a new arrow when one seemed bad. On this day, each girl shot six ends of arrows.

On May 6, a further discussion of aim was provided. The reasons for arrows going to the left were given. The common causes of this error are: poor aim, plucking, hand drawn to side of face instead of under the chin, humping the shoulder of the bow arm, releasing the arrow while it is falling away from the bow, aiming with the wrong eye, and jerking the bow arm at the moment of release. The members of the class were given individual correction as they shot. Each girl shot six ends of arrows.

On May 11, the instructor reviewed the reasons which cause the arrows to fly high. The instructor presented the reasons for arrows going low. The common causes of this latter error are: nocking crooked, poor aim, pulling to an anchor point high up on the face, creeping release, and dropping the bow arm at the moment of release. The class was given individual correction as needed. Each

girl shot six ends of arrows.

Period of Very Little Group Instruction.- On May 13, a third tournament was held. Instruction was given only to those who asked for it. Five ends of arrows were shot by each girl.

On May 18, no class instruction was given. The students were corrected individually as they shot. Each girl shot six ends of arrows.

On May 20, individual correction was continued. The group was instructed in the proper manner in which to put down points of aim. The blocks used for this were set on the floor with one corner turned toward the archer. The girl aimed at the corner of the block where it touched the floor. Each girl shot six ends of arrows.

On May 25, individual instruction only was given. Six ends of arrows were shot by each student.

The last day of the experiment was May 27. This was a tournament day. On that day, each girl shot three ends of arrows. Correction of errors was given only to those students who asked for it.

Scoring and Tabulating Results

Score Cards.- Each girl had her own score card and pencil. For a sample score card, see Appendix. As a girl took an arrow out of the target, she recorded its

point value. The score cards were collected and checked after each shooting period.

Percentage Scores.- The same number of arrows was not shot at each class period. On the days when the instructor gave a large part of the period to group instruction and explanation, less shooting was done. On other days the instructor took up less class time with demonstration and explanation. In order to compare the progress made from one practice period to another, the raw scores were converted into percentage of perfect score. This measure will be called percentage score throughout the remainder of this study.

For example, suppose five ends or thirty arrows were shot in any one practice period. The maximum possible score would be 270 points, earned by shooting all arrows into the gold. If the arrows scored 179 points out of the possible 270 points, the percentage score was fifty-five.

Learning Curves.- A learning curve, or graph of progress, was drawn for each girl. The units of the ordinate express percentage score. The units of the abscissae are days of practice. On this curve was recorded the percentage score of each student for each practice period. Lines were drawn connecting the points recorded, so that the graph of progress could be easily read.

Group Percentage Scores.- Group practice curves were compiled from the individual records. This was done by averaging the percentage scores of all the arrows shot by each member of the group for each practice period. From these average group percentage scores, the group learning curves were drawn.

Average Achievement.- The percentage scores for each student for all the practice periods were totalled and averaged. This gave the average percentage score for the student during the entire experimental period. To classify the students according to general level of performance during the experiment, they were ranked according to this average percentage score. This is called the total or average achievement. This measure was considered the best single indication of progress, and was used to compare the achievement of one student with another, and as a basis for correlating achievement in archery with various factors.

Method of Computing Correlations.- In order to compare relationship between performance or achievement in archery and any other score, the method of rank differences was used. It was decided to use Spearman's formula for rank differences rather than the Pearson Product Moment formula, because fewer than twenty-five cases were involved. Many statisticians recommend ranking scores in order of merit and computing the correlation by the rank

method when the number of cases is small. [4]

The Spearman formula for computing correlations by method of rank differences is:

$$\rho = 1 - \frac{\Sigma 6\, d^2}{N(N^2-1)}$$

ρ is the rank correlation coefficient
N is the number of cases
d is the difference between two paired ranks
Σd is the sum of the differences between the ranks

The differences between coefficients found by the method of rank differences and correlations found by the product moment method are so small that for most purposes the two may be considered equal. Pearson has made a table which can be used to convert rank difference coefficients into equivalent product moment coefficients. This table was used, and the corrected coefficient (r_ρ) is presented in the tables of correlations in this study.

The probable error of the corrected rank correlation coefficient was computed by using the following formula:

$$P.E._{r_\rho} = .7063\, \frac{1-r_\rho^2}{\sqrt{N}}$$

r_ρ is corrected rank correlation coefficient
$P.E._{r_\rho}$ is the probable error of the corrected rank correlation coefficient

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[4] Henry E. Garrett, Statistics in Psychology and Education, p. 360. New York: Longmans, Green and Company, 1937.

Chapter Summary

Summary.- Two archery groups participated in the experiment. Twenty-three girls started in each group, but only twenty from each group stayed throughout the whole experimental time. The data presented are for these forty girls.

The two groups were found to be highly similar as to central tendency and variability with regard to mental test scores, height, weight, and previous experience in physical education. There is reason to believe that at the start of the experiment the groups were essentially equal in their ability to learn archery.

The equipment used in the experiment consisted of target faces and backstops, bows, arrows, armguards, and finger tabs. A carefully designed series of lessons was presented to the tuition group. Only enough instruction was given to the non-tuition group to enable them to handle the equipment and shoot in safety.

An observer was present in each class every shooting period to make a record of the proceedings. Other sources of data include detailed records of all shots, photographs, introspective reports by the subjects, and records from interviews with the subjects as well as their answers to set questions.

From the data secured, learning curves were plotted and correlations were computed for archery achievement with various factors.

CHAPTER III

EFFECT OF TUITION UPON PERFORMANCE OF STUDENTS LEARNING ARCHERY

Introduction

This chapter will present data upon the progress of learning by the members of the parallel groups. The main topics treated are as follows: the effect of systematic instruction upon achievement, the effect of tuition upon rate of learning, and aspects of the learning curves obtained for the various subjects.

It was expected at the outset that the tuition class would progress faster than the other class. This assumption remained to be corroborated or disproved by the findings. The final achievement of each group, however, was not the chief interest of the investigator. The main interest in this experiment was in discovering how the two groups went about learning. The effect of tuition on the various phases of learning a skill was the chief point of interest.

Effect of Systematic Instruction upon Achievement

Initial and Final Scores of the Tuition Group.- The tuition group had been given instructions in the

technique of archery previous to the time of shooting the first arrows (for a record of the complete instructions given to the class, see Chapter II). During the first practice period the percentage score made by this group was fifteen (Table VI).

The highest percentage score reached by the tuition group was sixty-six. This score was attained on the next to the last practice period. On the day of the last practice period, this group dropped slightly in percentage score. On the final day of the experiment, the tuition group had a percentage score of 65 points (Table VI). This group gained fifty-one percentage points from its initial performance to its point of greatest achievement.

Initial and Final Scores of the Non-tuition Group.- The non-tuition group had been given only preliminary instructions in handling equipment and measures of safety. At the first practice period, this group made a percentage score of twelve points (Table VI).

This group reached its maximum percentage score on the last day of the experiment. On that day, the members of this group had a percentage score of forty-seven points (Table VI). This showed a gain of thirty-five percentage score points for this group during the experimental period.

Group Comparisons.- The members of the tuition

TABLE VI

AVERAGE PERCENTAGE SCORES OF EACH ARCHERY GROUP FOR THE FIRST PRACTICE PERIOD, THE NEXT TO THE LAST PRACTICE PERIOD, AND THE FINAL PRACTICE PERIOD

Groups	Average Percentage Score for First Practice Period	Average Percentage Score for Next to Last Practice Period	Average Percentage Score for Last Practice Period	Maximum Gain in Percentage Score
Tuition	15	66	65	51
Non-tuition	12	47	47	35

group started at a higher level of achievement on their first practice period than did the non-tuition group. The tuition group made an average score of three percentage points higher on the initial trials at shooting than did the non-tuition group.

The tuition group made a greater gain in score throughout the experimental period than did the non-tuition group. The group given systematic instruction gained sixteen points more in percentage score than did the uninstructed group.

These data show the results expected at the outset of the experiment. A class systematically instructed in an accepted technique of archery reached a higher level of achievement during the experimental period than did a class which was not so instructed.

Effect of Tuition upon Rate of Learning

Initial Period of Learning.- It was desired to obtain data on the rate of initial learning, and the rate of learning following the initial period. The initial period of learning may be considered to extend from the time of the first practice period to the time of the first drop in score made by either group. One reason for considering this period as the initial one was that, from the beginning of the experiment to the period of

the first drop in score, the trend of the total group learning curves for both groups remained fairly constant. The first loss occurred in the ninth period of practice, when the non-tuition group suffered a lowering of average score. The initial period of learning, then, was considered to comprise the first eight practice periods.

Rate of Initial Learning of the Tuition Group.- The average score of the tuition class rose steadily throughout the entire initial period of learning. The average score of this class rose eleven points between the first and second practice periods (Table VII and Figure 8). Following this second practice period, the gain in score for this class at consecutive periods of work was five, seven, three, five, two, and six points, respectively.

The tuition group reached a percentage score of fifty-four points on the eighth practice period. The total gain in score made by this group during the initial period of learning was, therefore, thirty-nine percentage score points.

Rate of Initial Learning of the Non-tuition Group.- The average score of the non-tuition group also rose steadily throughout the initial stages of learning. The average score of this class rose seven points between the first and second practice periods (Table VII and Figure 8). Following this second practice period, the

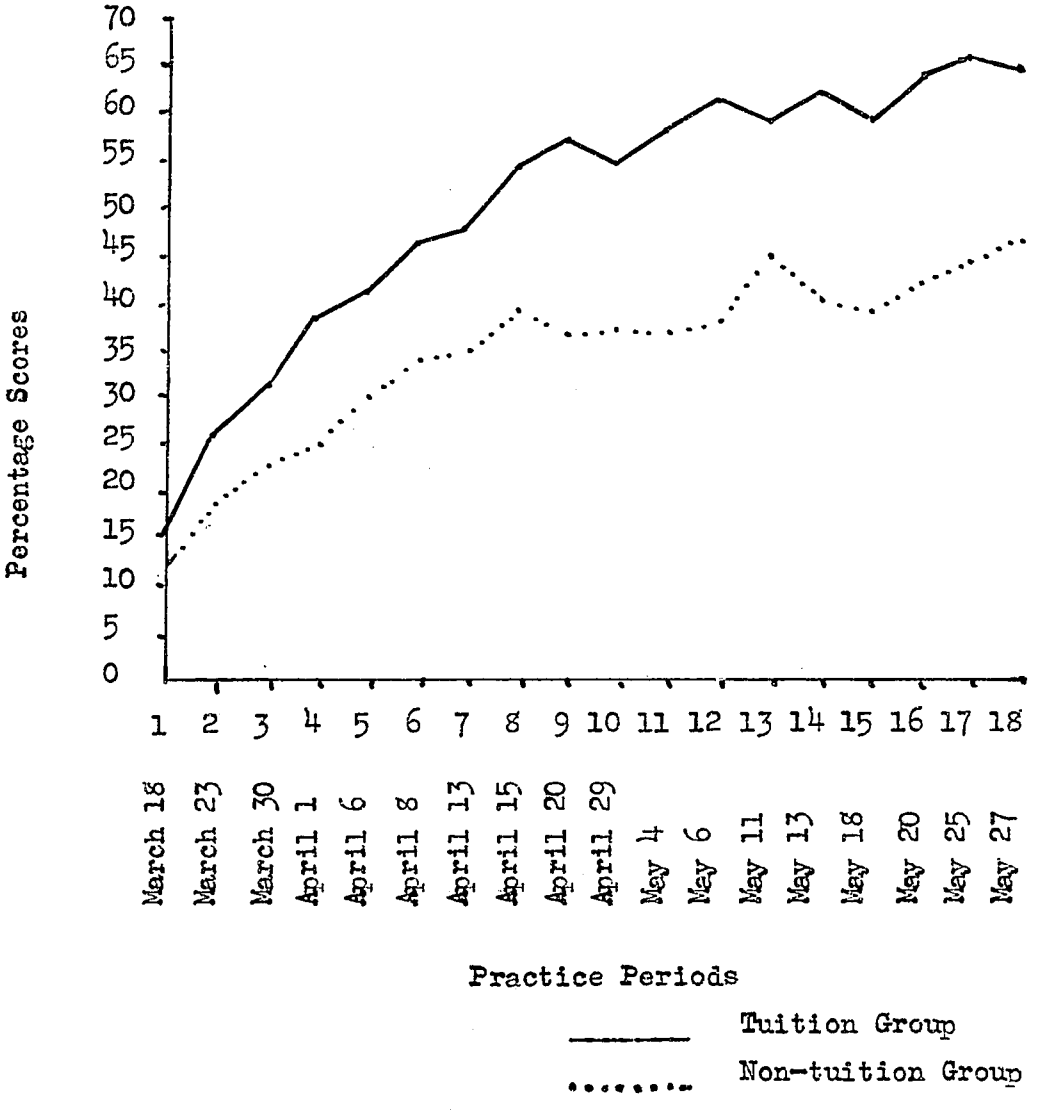

Figure 8.- Daily average percentage scores for the two archery groups.

TABLE VII

PERCENTAGE SCORE GAINED BY EACH OF THE TWO ARCHERY GROUPS DURING THE FIRST EIGHT PRACTICE PERIODS

Days of Practice	Dates	Percentage Score for the Two Groups		Difference
		Tuition	Non-tuition	
1.....	March 18	15	12	3
2.....	March 23	26	19	7
3.....	March 30	31	23	8
4.....	April 1	38	25	13
5.....	April 6	41	30	11
6.....	April 8	46	34	12
7.....	April 13	48	35	13
8.....	April 15	54	39	15
Total Gain in Score		39	27	12

gain in average score made by the group for the next six consecutive periods of work was four, two, five, four, one, and four points, respectively.

The non-tuition group reached a percentage score of thirty-nine points on the eighth practice period. The total gain in score made by this group during the initial period of learning was twenty-seven percentage points.

Comparison of the Initial Rate of Learning of the Two Groups.- The tuition group gained more each day than did the non-tuition group. With the exception of the fifth day of practice, the gap between the average scores of the two classes increased in extent with every practice period from the first period through the eighth. The total initial gain of thirty-nine points made by the tuition group was twelve percentage score points higher than the total amount of gain made by the non-tuition group.

Instruction in accepted work methods had the effect of increasing the initial rate of learning for the tuition group over the initial rate of learning of the non-tuition group.

Rate of Learning of the Tuition Group from the Initial Stage to the End of the Experiment.- On the eighth practice period, the tuition group had a percentage score of fifty-four points. The members of this group gained three more percentage score points on the

ninth day of practice. Following that period, the group suffered its first loss in average score. From that point until the end of the experiment, the scores for this class rose gradually, although three temporary losses occurred during this time. Each of these three losses was for one practice period only and was followed by a rise to a higher percentage score than any previously reached. The gain for the tuition group from the eighth practice period through the final day of practice was twelve percentage points (Table VIII).

Rate of Learning of the Non-tuition Group from the Initial Stage to the End of the Experiment.- The non-tuition class showed a percentage score of thirty-nine on the eighth day of practice. It had its first loss in score at the following period. On that day, the average score of the class dropped to thirty-seven percentage points. The score of the class remained at this level with practically no gain for the next three practice periods. Following this, the percentage scores of the group rose to forty-five points, a six-point gain over the previous high score. The average class score then dropped from this high, and remained at lower levels until the final practice day of the experiment. The percentage score for this group rose on the last practice period to forty-seven points. The gain for the non-

TABLE VIII

PERCENTAGE SCORE GAINED BY EACH OF THE TWO ARCHERY GROUPS FROM THE EIGHTH PRACTICE PERIOD THROUGH THE FINAL PRACTICE PERIOD

Days of Practice	Dates	Percentage Score for the Two Groups		Difference
		Tuition	Non-tuition	
8.....	April 15	54	39	15
9.....	April 20	57	37	20
10.....	April 29	55	37	18
11.....	May 4	58	37	21
12.....	May 6	61	38	23
13.....	May 11	59	45	14
14.....	May 13	62	40	22
15.....	May 18	59	39	20
16.....	May 20	64	42	22
17.....	May 25	66	44	22
18.....	May 27	65	47	18
Total Gain in Score		12	8	4

tuition group from the eighth through the eighteenth practice period was eight percentage score points (Table VIII).

Comparison of Rate of Gain Made by the Two Groups from the Initial Stage of Learning to the End of the Experiment.- The difference between the gains of the two classes for the latter part of the practice was four percentage score points. While this is not a large difference, it does show that the tuition group progressed at a faster rate than the non-tuition group for the latter part of the practice period. The progress of the two groups is shown graphically in Figure 8.

Aspects of the Learning Curves

Shape of the Learning Curves.- The shapes of learning curves take various forms, depending on the way in which they are plotted. The most common method of plotting the curves has been to plot scale units along the abscissa to express equal units of practice; the scale units of the ordinate usually express equal units of achievement. Using this method of plotting curves, most of the investigators interested in motor learning have found that the practice curves showed a sharp initial rise in performance, and have been negatively accelerated.

The learning curves plotted from data obtained

in this investigation are similar to those found in the experiments involving typewriting, telegraphy, and ball tossing.

The group curve for the tuition class in archery, as has been pointed out, shows a sharp initial rise in performance from the first through the ninth practice period. The group curve for the non-tuition class also shows a sharp initial rise in performance. This rise in score extends from the first practice period to the eighth day of practice.

Although the rate of gain is different for each group, the same negative acceleration in performance is common to the curves drawn from the data obtained from each group. The data at hand suggest that learning curves plotted to show the progress of subjects learning a complex motor skill with the aid of an instructor are similar in shape to the curves showing the progress of subjects learning a complex skill by means of practice without tuition. Whether or not this generalization is true, the curves actually plotted for the experimental and control groups are markedly similar in pattern.

Irregularities in the Learning Curve of the Tuition Group.- Group curves, constructed by averaging individual learning scores, usually have the effect of smoothing and tending to neutralize the irregularities

shown in the individual curves.

Figure 8 shows graphically that the tuition group suffered four drops in score during the total experimental period, but that in each case the loss was for one practice period only. No setback was greater than three percentage score points. Each loss was followed by a rise which brought the percentage score to a new level of accomplishment higher than any ever before reached.

The group and individual records were searched to try to discover causes for these drops in score. April 29, the day on which the tuition class suffered its first loss in score, was the first day of practice following a week's vacation from school. The students in the class had had no practice in shooting on the previous Tuesday or Thursday. This interruption of a week in practice may easily account for the loss.

The second drop in score which this group suffered was on May 11. The individual records of some of the class members indicated that the students mentioned that they had not obtained their usual amount of sleep the night before. This was due to the fact that there had been a terrific wind storm and rainfall on that night. Many of the students lived on farms, and reported that they had had to work during the night bringing in chickens and seeing that other farm animals were pro-

tected from the storm. Since the tuition group met at ten o'clock in the morning, the students had not had a chance to recover from their lack of sleep and from the excitement of the night before.

The third drop in score noticed in this group was on May 18. The records for this day do not indicate any cause which might account for this slump in score.

The final slight drop in score made by the tuition group occurred on the last day of the experiment. This drop may be due to the fact that fewer arrows were shot on that day than on any day since the third practice period. The group may have needed a more extended work period in order to reach a maximum level of performance.

Irregularities in the Learning Curve of the Non-tuition Group.- Figure 8 portrays a different picture for the non-tuition class. While this class had two drops in score, each was followed by a period of lowered performance which lasted through four practice periods. The first drop, occurring on April 20, was slight, but performance failed to improve materially for three subsequent periods. The largest single loss in score suffered by either group occurred to the non-tuition group on May 13.

The records of this group were reviewed to try to discover causes for the two periods of lowered performance that were noted in the group curve.

April 20 was the day before the spring vacation. The non-tuition group met at two o'clock in the afternoon. For many of the members of this group, the archery class was the last one that they were required to attend before the holiday. The excitement aroused by the prospect of the holiday, plus the desire to leave school to go home, may have caused the performance of this group to drop on that day. This was also the day of the second tournament.

The performance of the group remained at this lower level for two more practice periods before it was raised. This might be accounted for by the fact that due to the week's vacation from school the students had missed two practice periods. The members of this group may have found it difficult to raise their scores after an interruption in practice.

No evidence could be found to account for the drop in score shown on the record of the non-tuition group for May 13. This was the third tournament day of the experiment. Since this group had a drop in score on two successive tournament days, it might be that the pressure to do well in the tournament was particularly disturbing to the members of the group. But this third tournament day (May 13) was followed by a day of still lower performance, followed by a gradual rise for three practice periods, at the end of which time performance had reached

a new high level. No evidence was found to account for this prolonged period of lowered performance.

Comparison of the Irregularities Noted in the Learning Curves of the Two Groups.- Tuition did not prevent losses in score from occurring. The group that was instructed had four drops in score. In each case, the drop was followed on the next day of practice by a rise to a higher score than any previously reached. However, the non-tuition group had drops in score followed by periods of lowered performance of much longer duration than those of the tuition group.

Plateaus or Delays in Learning.- Plateaus or delays in learning have been found in some practice curves. These delays in achievement have been absent from many curves plotting the progress of subjects learning a motor skill.

The group records of the class given systematic instruction in archery during the present investigation show no prolonged period where no learning was recorded (Figure 8). Except for four losses in score, each of which lasted only one day, the tuition group gained in achievement throughout the whole experiment.

The data obtained from the non-tuition class show two periods in the learning process when very little learning could be noticed. The first of these periods

lasted four days. It started on the ninth practice period, March 20; it lasted during March 29, May 4, and May 6. During the first three days of this plateau in learning, the percentage score of the group remained at the same level. On the final day of the delayed learning period, the average class score rose one percentage point.

The second sustained period of little improvement in learning occurred in the records of this group between May 13 and May 25. This period may or may not be considered a true plateau of learning. For four practice periods, the percentage score of the non-tuition group remained below the peak reached previously. On May 11, the class scored forty-five percentage points. This group suffered a five point drop in score on the next practice day, held May 13. On May 18, the percentage score of this group dropped one more point. During the next two practice periods, the group score rose slowly, gaining three points on May 20, and two points on May 25. On that day the group score was still below the height reached four practice periods previously.

The members of both classes wanted to improve their scores throughout the whole experiment. They were all motivated by the desire to attain a higher score than the other members of the same group. However, it seemed during this experiment that the non-tuition group became discouraged easier than did the tuition group. The mem-

bers of the non-tuition group also talked more to each other about their progress and lack of progress than did members of the tuition group. It is possible that the discouragement felt by one or two members of the non-tuition group was spread throughout the entire group by means of this conversation. This might account in some measure for the plateaus in the practice curve of the non-tuition group.

Individual Learning Curve for Member of the Tuition Group.- The records of the percentage scores of each girl in the tuition group are shown in Table IX. These records reveal many more daily fluctuations than appear on the group charts. Figure 9 is a sample learning curve of subject O in the tuition group. The record of any other girl's progress could just as well be used as an example. All the curves vary one from the other. No two are alike. The similarities can only be obtained by combining the individual data into group data. Marked irregularities are seen in all the individual records. Irregularities similar to these have been noted in individual graphs of learning drawn from data on subjects learning typewriting, ball tossing, telegraphy, and other motor skills.

O's percentage score started at thirty points (Figure 9) and rose nineteen points on the second day. It dropped twenty points the third day, rose nineteen

TABLE IX

PERCENTAGE SCORES MADE BY EACH MEMBER OF THE TUITION GROUP DURING THE EXPERIMENTAL PERIOD

Subjects	Dates of Practice Periods							
	March 18	March 23	March 30	April 1	April 6	April 8	April 13	April 15
Calvin....	26	35	32	34	44	34	35	43
Clark.....	36	15	32	38	37	39	34	53
Douglass..	1	33	12	37	55	54	31	46
Etherton..	5	25	35	18	26	32	41	42
Farlow....	25	39	55	58	46	46	62	72
Fisher....	30	49	29	48	46	61	67	76
Heatherly.	16	18	9	28	36	45	40	38
Huey.....	2	18	26	52	54	63	60	62
Johnson...	12	36	31	41	45	26	33	38
Jones.....	8	24	28	36	38	46	52	65
McCallum..	21	19	45	36	37	40	51	42
Mullinax..	0	27	14	32	27	35	34	42
Obermark..	9	23	30	36	38	43	61	55
Sager.....	17	22	31	37	48	42	50	53
Smith.....	23	28	36	42	41	61	60	63
Souther...	11	17	31	30	44	56	56	51
Thompson..	15	15	42	31	28	49	37	59
Wilson....	14	28	39	47	44	46	57	50
Wright....	13	16	28	38	58	55	58	71
Young.....	9	23	28	34	35	37	46	54

TABLE IX (Continued)

Subjects	Dates of Practice Periods									
	April 20	April 29	May 4	May 6	May 11	May 13	May 18	May 20	May 25	May 27
Calvin....	47	47	43	55	60	68	49	54	65	55
Clark.....	50	42	57	47	39	55	55	45	54	53
Douglass..	61	60	55	53	49	68	64	63	71	62
Etherton..	40	54	58	65	57	57	68	61	66	69
Farlow....	72	74	53	76	73	75	75	68	75	59
Fisher....	68	75	76	70	65	70	63	71	70	71
Heatherly.	47	39	46	53	42	51	48	58	56	65
Huey.....	58	60	77	61	69	64	75	73	81	74
Johnson...	27	63	75	69	55	47	62	74	66	62
Jones.....	51	44	53	64	56	61	55	58	64	62
McCallum..	50	57	63	69	63	72	66	75	82	66
Mullinax..	41	36	39	38	58	47	55	60	61	65
Obermark..	62	55	46	54	61	62	48	73	60	69
Sager.....	67	58	59	59	58	58	65	72	59	72
Smith.....	77	65	46	58	49	65	43	66	73	69
Souther...	64	63	67	67	72	60	65	55	58	74
Thompson..	70	47	55	69	65	61	66	67	75	76
Wilson....	58	60	59	61	61	60	46	51	65	55
Wright....	76	72	82	78	76	77	80	74	73	70
Young.....	45	33	47	45	59	45	34	63	41	61

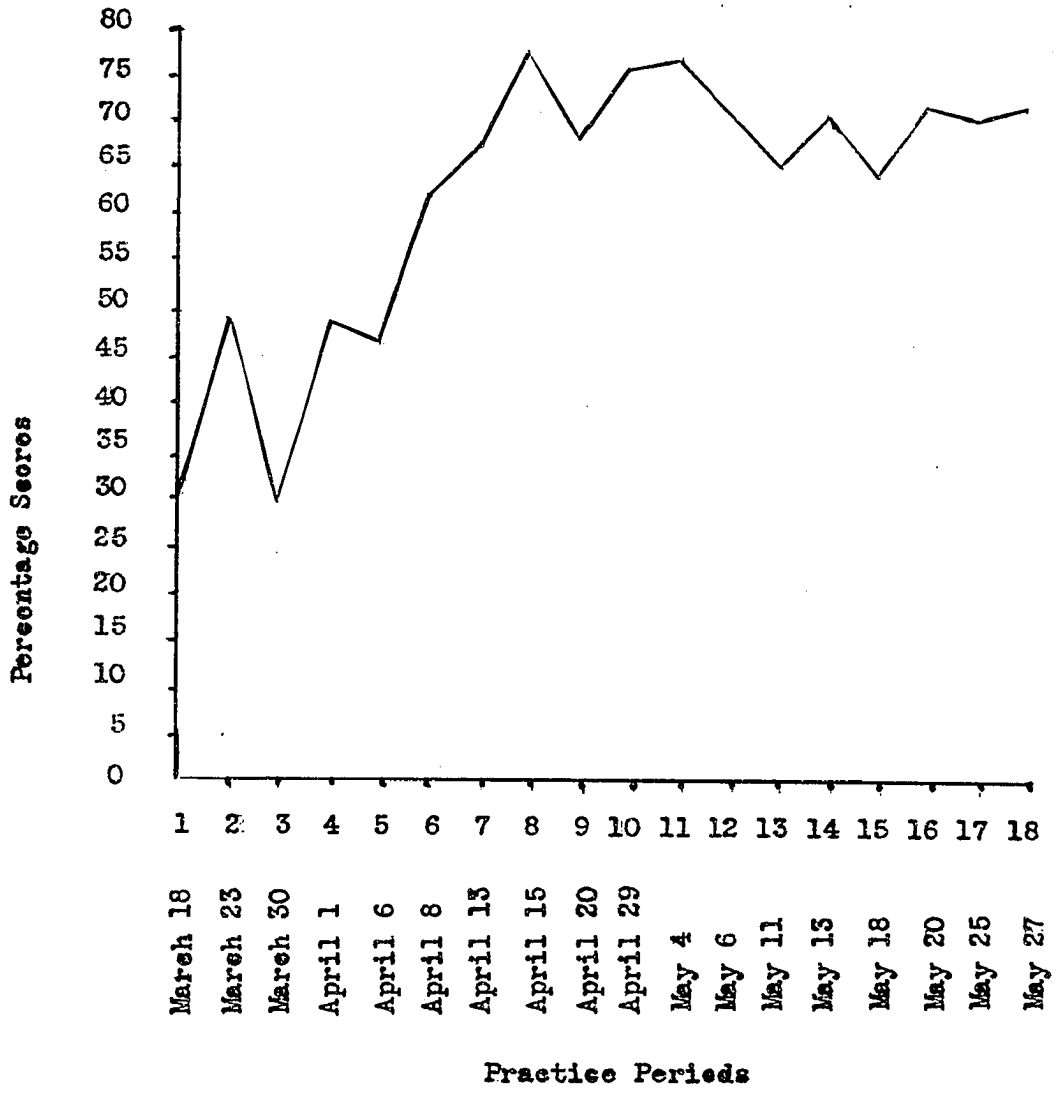

Figure 9.- Percentage scores of subject O in the tuition group during experiment on learning archery.

points the fourth day, dropped slightly on the fifth, and rose during the sixth, seventh, and eighth practice periods to the highest point it reached throughout the experiment. O's score dropped on the ninth practice day, but rose on the tenth day to a point almost as high as that reached on the eighth practice day. It made a slight gain on the eleventh day. This subject's score dropped on the twelfth and thirteenth days, rose on the fourteenth, dropped on the fifteenth, rose on the sixteenth, dropped slightly on the seventeenth, and rose on the final day of the experimental period. The score of this subject did not again reach the peak it had attained on April 15.

Individual Learning Curve for Member of the Non-tuition Group.- Table X gives the record of percentage score of each girl in the non-tuition group. Figure 10 is a graph drawn from the data on subject X of the non-tuition class. The record from any other member of the group would do equally well for an example. X's percentage score started at nine points. It rose nineteen points on the second day. It dropped three points on the third day, and rose on the fourth to equal its record of the second day. The score rose on the fifth and sixth practice periods, dropped on the seventh, and rose on the eighth. It dropped on the ninth, rose on the tenth, and dropped on the eleventh day. The score rose somewhat on the twelfth,

TABLE X

PERCENTAGE SCORES MADE BY EACH MEMBER OF THE NON-TUITION GROUP DURING THE EXPERIMENTAL PERIOD

Subjects	Dates of Practice Periods							
	March 18	March 23	March 30	April 1	April 6	April 8	April 13	April 15
Baldwin.....	33	39	17	47	37	37	48	54
Cheney.....	0	5	9	6	10	21	17	28
Davis.....	12	12	20	14	34	28	23	28
Dennis.....	11	11	32	33	33	44	49	53
Freeberg....	20	15	19	34	35	51	58	51
Garrison....	9	28	25	28	32	42	30	46
Holmes.....	5	17	14	27	42	42	48	48
Homberg.....	9	22	26	21	20	31	29	31
Jackson.....	0	3	4	17	13	7	11	17
Konya.....	11	32	31	35	40	47	41	42
Laffoon.....	14	46	54	47	55	48	67	51
Mitchell, L.	30	18	27	32	37	36	44	45
Mitchell, T.	16	15	18	15	9	24	40	49
O'Rourke....	27	17	29	14	37	38	46	51
Rodeck.....	7	20	19	19	23	25	20	28
Russell.....	17	22	23	15	39	40	32	39
Spriggs.....	3	7	18	14	21	25	30	38
Tisdale.....	0	12	20	27	33	28	34	37
Wagner.....	4	25	23	17	29	28	26	17
Williams....	5	13	36	28	30	34	16	32

TABLE X (Continued)

Subjects	Dates of Practice Periods									
	April 20	April 29	May 4	May 6	May 11	May 13	May 18	May 20	May 25	May 27
Baldwin.....	45	43	41	49	49	42	40	43	36	46
Cheney.....	22	16	15	14	29	20	25	12	35	30
Davis.....	30	20	25	22	22	22	23	17	29	44
Dennis.....	34	30	45	38	40	40	32	34	20	35
Freeberg....	46	32	46	46	43	39	44	43	43	41
Garrison....	35	45	34	39	60	48	52	51	53	43
Holmes.....	45	39	48	49	59	55	60	55	70	60
Homberg.....	30	35	32	26	49	44	35	35	33	31
Jackson.....	21	35	25	22	40	17	11	21	18	12
Konya.....	43	28	41	47	50	32	34	58	46	56
Laffoon.....	60	50	43	53	55	62	47	68	69	78
Mitchell, L.	40	45	49	34	41	37	47	48	50	68
Mitchell, T.	31	47	43	46	46	25	39	45	42	60
O'Rourke....	45	47	34	50	64	55	50	58	70	60
Rodeck.....	32	50	46	41	54	54	41	37	59	65
Russell.....	27	24	26	42	34	33	39	38	31	67
Spriggs.....	38	45	42	32	44	46	44	47	35	36
Tisdale.....	32	35	36	44	45	39	45	47	49	46
Wagner.....	25	27	40	37	42	52	40	42	50	61
Williams....	48	46	34	37	39	36	41	41	33	28

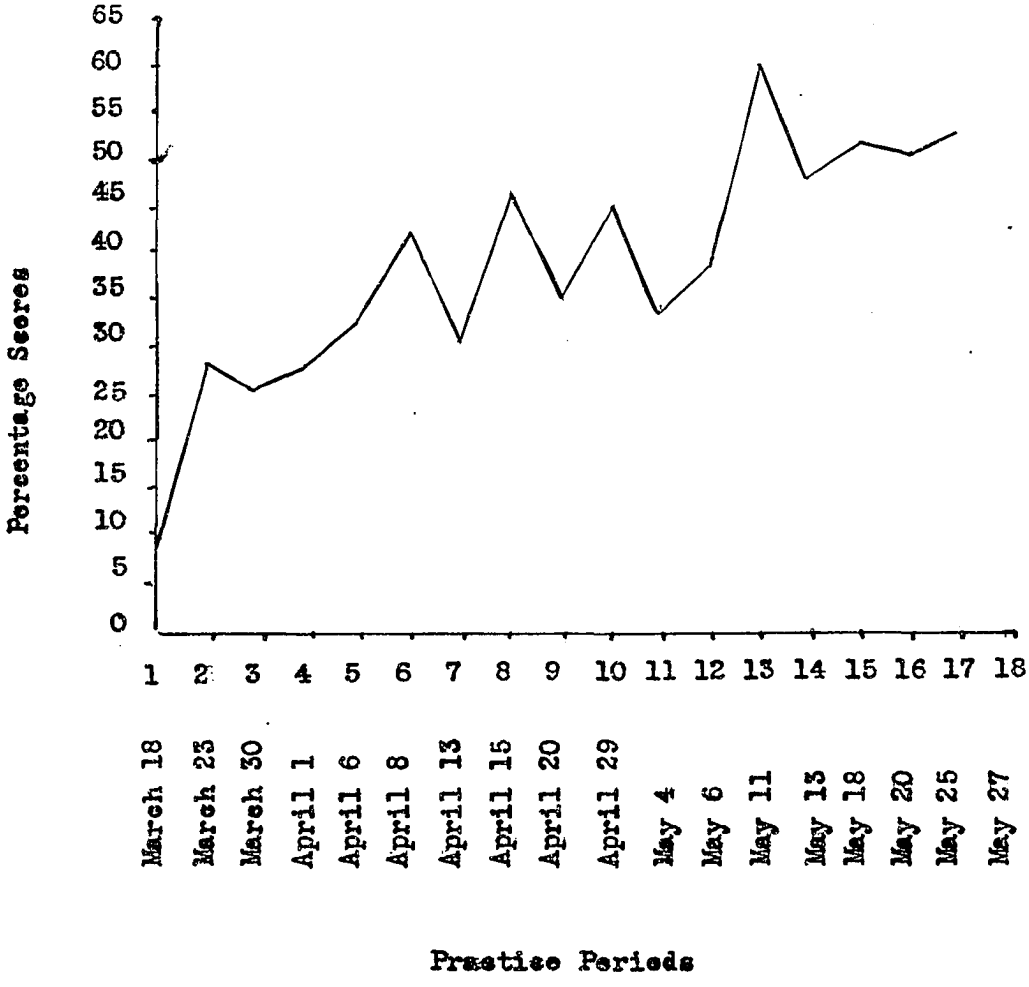

Figure 10.- Percentage scores of subject X in the non-tuition group during experiment on learning archery.

and took a twenty-one point jump on the thirteenth day to the highest peak it reached during the experiment. From here, the score dropped on the fourteenth day, rose on the fifteenth, dropped one point on the sixteenth, rose slightly on the seventeenth, and dropped back ten points for the final practice period.

Comparison of the Irregularities in Score in the Two Groups.- To discover what effect tuition made upon the consistency of individual performance, it was determined to count the number of irregularities found in each individual curve. By an irregularity in a curve is meant a movement of the curve upward followed by a movement downward, or vice versa. The total irregularities for each individual were added to the corresponding total for each other member of the group. In this manner, a figure was obtained to represent the number of irregularities found in each group.

On this basis, the data for the members of the tuition group showed ninety-nine peaks and ninety valleys. The non-tuition group had ninety-four peaks and eighty-nine valleys. This shows slightly more irregularities in the curves of the tuition group than in those of the non-tuition group.

This difference is slight, showing nine more peaks and one more valley occurring among the curves of

the members of the tuition group than among the curves of the non-tuition group. This can be interpreted to mean that tuition in archery had little effect upon the irregularities in performance of the members of the group.

Summary

As was to be expected, the instructed subjects started at a higher level of performance than did the uninstructed ones, and maintained superiority throughout.

The tuition group progressed at a faster rate than did the non-tuition group, during both the initial and the latter stages of learning.

The characteristics commonly noted in learning curves for motor skills appear in the data of this chapter: rapid initial progress, a gradual slowing down of the rate of gain, irregularities in composite curves more or less related to the general conditions of work and motivation, occasional appearances of plateaus or periods of slow progress, and large irregularities in the individual curves.

Curves drawn from data gathered from subjects learning a complex motor skill were similar whether or not the subjects were given instruction in the technique of shooting a bow and arrow.

CHAPTER IV

PERSONAL FACTORS RELATED TO PERFORMANCE AND IMPROVEMENT IN ARCHERY

Introduction

Factors Potentially Related to Skill in Archery.- Teachers of motor skills are naturally interested to determine the relationships of these skills to various factors that might affect learning in these fields. This chapter is concerned with evidence on certain factors of general ability, physique, past experience, and personality as these appear to be related to achievement in archery.

Topical Organization of Chapter.- The major topics treated are described briefly in the following paragraphs.

(1) The relationship of general mental ability to success in archery has been computed by one experimenter. Data will be presented on this problem as found in the present experiment.

(2) Height and weight have been found by earlier investigators to have a slight bearing on proficiency in archery. Data will be presented on these factors.

(3) It is widely believed that experience gained in one sport transfers to learning in other sports. The

previous physical education experience of the subjects of this study was investigated, and data will be presented on this experience as related to learning archery.

(4) Archery is in some respects a highly individualized sport. General personality traits may have significance for success in learning archery. A typical personality test, the Bernreuter Personality Inventory, furnished data which will be presented on certain personal traits as possible factors in success in archery.

Statistical Treatment.- In each section of this chapter, correlation coefficients are presented, showing the relationship between achievement in archery and the trait or traits considered. The coefficients were computed separately for the tuition and the non-tuition groups. The rank-difference method was used, in view of the small number of cases in each group. However, the rank-difference coefficients (ρ) were transmuted into equivalent product-moment coefficients (r_ρ) by table, [1] and the probable error of the transmuted coefficients (P.E.r_ρ) was computed, and then checked by nomograph. [2]

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[1] Henry E. Garrett, Statistics in Psychology and Education, p. 361. New York: Longmans, Green and Company, 1937.

[2] Jack Dunlap and Albert Kurtz, Handbook of Statistical Nomographs, Tables, and Formulas, pp. 42-43. New York: World Book Company, 1932.

Relationship between Test Scores on Mental Ability and Ability in Archery

Consideration of Mental Ability as a Factor in Learning Archery.- It might be logical to assume that the students who have a high score on mental tests would be able to profit more by instruction in archery than would those of lower mental ability. The students with high mental ability should be able to understand and follow directions given by the instructor better than could students of lesser mental ability.

Hyde [3] studied the relationship between the mental ability and achievement in archery existing in a group of students all of whom were past the first stages of learning archery. She found no relationship between the two factors being compared. In this present study, the interest was centered on whether the group given instruction in archery showed a closer relationship between archery ability and mental ability than did the group which was given no instruction in the skill. From these facts it might be possible to draw conclusions concerning the ability of students to learn a motor skill, and the ability of students to profit by instruction in such a skill.

Mental Test Given.- All of the students enrolled

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[3] Edith M. Hyde, "The Measurement of Achievement in Archery," Journal of Educational Research, XXVII (May, 1934), 72-86.

in the two archery classes took the Otis Self-Administering Tests of Mental Ability, Higher Examination: Form B. This test was given on March 9 at the first meeting of each class.

Most of the students made scores above forty-two, which is the score level reported by Otis as the average for an unselected population. The students in this study were, then, typical of most college students whose level of test scores is superior to that of an unselected adult population.

Correlation between Mental Ability Test Scores and Ability in Archery.- The correlation between the scores for mental ability and the achievement scores is .42 for the tuition group. The probable error for this is .13. The correlation for the non-tuition group is .15. This has a probable error of .15 (Table XI).

These figures show that there is no significant relationship between achievement in archery and the test scores of mental ability of the students in the group who learned without the aid of instruction.

These figures do show that there is a slight relationship between the mental ability test scores and the average percentage scores of students being given systematic instruction in archery. The brighter students in this group tended to profit more by instruction than did the duller students.

TABLE XI

RELATIONSHIP BETWEEN SCORES ON MENTAL TEST AND ARCHERY SCORES FOR INSTRUCTED AND UNINSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.r_ρ
Tuition	.41	.42	.13
Non-tuition	.15	.15	.15

Proficiency in archery acquired by normally intelligent students by means of uninstructed practice appears to have little relationship to the mental ability of those students. But the ability of students to progress in archery under the tutelage of an instructor varies to some degree with the mental ability of those students, so far as the data at hand show.

Relationship between Height and Weight and Ability in Archery

Consideration of Height as a Factor in Ability to Learn Archery.- Taller archers have longer arms than do shorter archers. For this reason, the taller girl can draw a certain bow farther back than can a shorter girl. The tension of the bow string is increased for every inch it is drawn back. Therefore, the more tension the string has, the greater force it has to send the arrow toward the target. The arrow with greater force goes straighter than the arrow with less force because air pressure and gravity influence it less. Thus, the taller girl, using a bow of the same poundage as a shorter girl, has an advantage over the shorter girl.

The average percentage score for each girl in the tuition group was computed, and the girls ranked accordingly. Each girl was also ranked according to her height in inches. The correlation between these two was then computed.

Correlation between Height and Ability in Archery.- The results of this computation show that the archery ability of the members of the non-tuition group is related to their height. The correlation for this group is .53. The probable error of this coefficient is .12 (Table XII). This shows there is a definite relationship existing between the two factors for the girls in the non-tuition group. The taller girls tend to be the better archers. Hyde [4] found a low positive correlation between height and archery ability in her study of archers.

In the tuition group there is a correlation of .02 between the archery scores and the height of the group members. This correlation has a probable error of .15. (Table XII). Thus, the students who were taught an accepted form in archery did not show a relationship between their scores and their height. The tuition given to a group appears to nullify the relationship between height and achievement. The initial advantage which superior height gives to some students seems to be overcome by tuition. The instruction given to each girl evidently influenced her progress and achievement more than did mere physical height.

Relationship between Weight and Performance in Archery.- A previous study in archery showed that there is a slight positive correlation between the weight of the

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[4] Edith M. Hyde, op. cit., pp. 72-86.

TABLE XII

RELATIONSHIP BETWEEN HEIGHT AND ARCHERY SCORES FOR INSTRUCTED AND UNINSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	.02	.02	.15
Non-tuition	.52	.53	.12

student and her achievement in archery. [5] The heavier girls were better archers than the lighter girls.

In the present study, the students were ranked in order of weight. The students were also ranked according to average percentage score for archery. The correlations secured from these data are shown in Table XIII. The correlation between weight and percentage score in the tuition class is .10. This has a probable error of .15. The correlation between these same factors in the non-tuition class is .39. This has a probable error of .13.

From these figures, it can be seen that there is no correlation between weight and archery ability among beginning students who are being instructed in archery. The probable error is greater than the amount of relationship shown. Therefore, weight is not an important factor in learning archery under the guidance of an instructor.

A slight relationship between weight and archery ability may exist among the members of the non-tuition group. Here the relationship is .39, with a probable error of .13. The interpretation which must be put on these figures is that the weight of a student may be slightly related to her skill in archery. A heavier girl has a slight advantage over the lighter girl in learning archery

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[5] Edith M. Hyde, op. cit., pp. 72-86.

TABLE XIII

RELATIONSHIP BETWEEN WEIGHT AND ARCHERY SCORES FOR INSTRUCTED AND UNINSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	.10	.10	.15
Non-tuition	.38	.39	.13

without the aid of instruction.

Interpretation of Correlations for Weight.- There may be two reasons why weight may have some bearing upon performance in archery. The taller girls usually weigh more than do the shorter girls; and, since there is a relationship between height and ability in archery when no tuition is given, there is likely to be a relationship between weight and performance in archery.

The second reason that weight may influence ability in archery has to do with strength. Larger girls are often stronger than smaller girls, although this is not always so. The strength of an archer makes it easier for her to shoot during the earlier trials in archery, because she can concentrate upon aim and technique rather than have all of her attention taken up with the effort of pulling the bow string.

Relationship between Achievement in Archery and Previous Physical Education Experience

Consideration of Previous Physical Education Experience as a Factor in Learning Archery.- Teachers and psychologists are interested in the transfer of training from one skill to another. There are differences of opinion as to how this transfer takes place. It was not one of the problems of this investigation to study the

method of transfer. This study was interested in the effect tuition would have upon girls who had various amounts of physical education experience. From this, it was hoped that it might be discovered whether past experience in physical activities was of much importance in the ability of students to learn archery.

Difficulty of Securing Accurate Data.- It was recognized that it would be impossible to secure information regarding the exact amount and type of previous experience any girl had engaged in. It was also recognized that measuring previous experiences in the field of motor skill was impossible.

The students who participated in this experiment came from widely varying homes, schools, and communities. Most of them had had very little formal training in physical education. A few of them came from schools where a physical education program was offered to all students. Some of the students had participated in sports in their homes, but many had not.

Method Used to Obtain Data.- An approximate measure of the amount of physical education experience of each student was secured by counting the number of years and terms of her experience in school-instructed physical education and in organized school sports.

Physical education activities are usually divided into terms to correspond with the weather. Each

season consists of one term of work. Three terms are included in one school year. If a girl had taken part in physical education classes in high school for one year, and participated one term in high school basketball, then had played one season each of hockey, basketball and softball in college, she was recorded to have had two and a third years of previous experience in physical education. For purposes of computation, the fact that class work in physical education and experience in sports might have been concomitant was disregarded.

Correlation between Achievement in Archery and Previous Physical Education Experience.- The students in the non-tuition group were found to have had from one year to ten and a half years of previous physical education experience. The tuition group varied in experience from two to ten years.

The relationship between previous physical education experience and ability in archery is shown in Table XIV. The correlation between the two scores is .18 for the tuition group. This has a probable error of .15. The correlation is .37 in the non-tuition group. The probable error of this coefficient is .13.

This shows that there may be a small positive relationship existing between physical education experience and archery ability among students who learn archery with-

TABLE XIV

RELATIONSHIP BETWEEN PREVIOUS PHYSICAL EDUCATION EXPERIENCE AND ARCHERY SCORES FOR INSTRUCTED AND UN-INSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	.18	.18	.15
Non-tuition	.36	.37	.13

out assistance from a teacher. The students who had more experience in other forms of physical skill may have a slight advantage in learning archery by their own efforts than have those students who had less previous experience in physical skills.

The carry over in skill from previous physical education experience to archery achievement among students who learn with the assistance of a teacher appears to be so slight as to be almost non-existent. The probable error of the coefficient is almost as large as the coefficient itself. This means that the previous physical education experience of students being systematically taught archery is not very important in their final achievement.

Relationship between Certain Personality Traits and Achievement in Archery

Personality Test Given.- The Personality Inventory, by Bernreuter, was given to all subjects on March 25, 1943. This inventory measures several aspects of personality. From the test, the author has devised six scales. The scales used for this investigation were those designed to measure sociability, neurotic tendency, and self-sufficiency.

Consideration of Sociability as a Factor in Learning Archery.- Archery is an individual sport. It

can be participated in by a person who pays no attention to anyone around him. It is possible to shoot at a target when nobody else is present. Archers rarely talk while they are shooting. An archer can be as independent and solitary as he wishes to be. Because of the nature of archery, it might be possible that people who dislike crowds and sociability would like archery, and therefore would become superior archers. For this reason, it was decided to test the sociability of the archers in this experiment, and to compare this ranking with the average rank each girl made in archery.

Correlation between Scores of Sociability and Achievement in Archery.- The section of the Personality Inventory which tests the sociability of the individual is intended to rate high those personalities who are independent, solitary, and non-social. Those scoring low tend to be sociable and gregarious. If the good archers are those who are independent and solitary, then their test scores should be high, and the correlation should show a negative relationship with sociability.

The correlation between sociability and percentage score in the tuition group is .14. The probable error of this coefficient is .15. The non-tuition group shows a correlation of .20, with a probable error of .15 (Table XV). Both of these correlations are so low that they can be re-

TABLE XV

RELATIONSHIP BETWEEN TEST SCORES ON SOCIABILITY AND ARCHERY SCORES FOR INSTRUCTED AND UNINSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	.14	.14	.15
Non-tuition	.20	.20	.15

garded, for all practical purposes, as negligible.

Evidently, whether a student is sociably inclined or not has little to do with her achievement in archery. This statement holds for both groups in this study, the tuition and the non-tuition.

Consideration of Neurotic Tendency as a Factor in Learning Archery.- Students who excel in archery maintain a calm manner. Any display of temper or nervousness may lead to physical reactions which are harmful to the archer's score. If the archer's bow arm shakes, she cannot hold a steady aim and therefore does not shoot accurately. If the archer is so excited that she throws her releasing hand sideward and plucks the bow string, she sends her arrow crooked. Any outward manifestation of nervousness on the part of the archer will cause her performance to be poorer.

Because the archer needs to be steady, there might be a relationship between her emotional stability and her shooting ability. If such a relationship exists, the emotionally stable individual might be expected to perform better than the unstable individual. A comparison of the test scores of neurotic tendency made on the Personality Inventory and the percentage scores in archery was made, and the correlations computed.

Correlation between Test Scores of Neurotic

Tendency and Achievement in Archery.- The results of this comparison show that in both groups there is practically no correlation between archery achievement and neurotic tendency. The tuition group correlation is .25. This coefficient has a probable error of .14. The non-tuition group has a correlation of .01 with a probable error of .15 (Table XVI).

Consideration of Self-sufficiency as a Factor in Learning Archery.- The individuals participating in archery need to be dependent upon their own ability. They have no partners or teammates to encourage or assist them. Therefore, it might be logical to suppose that a good archer needs to be self-sufficient.

Correlations between Achievement in Archery and Test Scores of Self-sufficiency.- The person scoring high on the test of self-sufficiency prefers to be alone, rarely asks for sympathy or encouragement, and tends to ignore the advice of others. Those scoring low dislike solitude and often seek advice and encouragement.

The correlations between self-sufficiency and archery ability were computed. For the tuition group the correlation is -.43, with a probable error of .13. The correlation of the two scores in the non-tuition group is .13. This coefficient has a probable error of .15 (Table XVII).

TABLE XVI

RELATIONSHIP BETWEEN TEST SCORES ON NEUROTIC TENDENCY AND ARCHERY SCORES FOR INSTRUCTED AND UNINSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	.24	.25	.14
Non-tuition	.01	.01	.15

TABLE XVII

RELATIONSHIP BETWEEN TEST SCORES ON SELF-SUFFICIENCY AND ARCHERY SCORES FOR INSTRUCTED AND UNINSTRUCTED SUBJECTS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	-.42	-.43	.13
Non-tuition	.13	.13	.15

Interpretations of Correlations.- There is practically no relationship between the self-sufficiency of the students in the non-tuition group and their achievement. The ones who depended on others for advice seemed to progress as well as those who depended upon their own resources. These results were contrary to the expectations of the investigator, who assumed that the self-sufficient students would excel in a sport when they were left to their own devices.

A possible explanation of the above results might be found in the method by which those students seemed to acquire their technique in archery. As will be explained in detail in Chapter VI, the students in this group "happened" upon a form of shooting during the first few practice periods. From that time on they kept, in general, this same technique.

The correlation between self-sufficiency and ability in archery in the tuition group is quite different from that of the non-tuition group. In the tuition group, a relationship seems to exist between the two factors. The students who tended to ignore the advice of others had poorer scores, on the whole, than the students who sought advice and encouragement from others. Students who profited most by the instructions given were those who do not try to depend on their own efforts, but sought the ad-

vice of others.

Summary

Summary.- For each of the two groups, the relationship between achievement in archery and several measurable traits was investigated. It was assumed that those relationships might be different for the two groups. The traits considered were: general intelligence, height, weight, experience in physical education, sociability, neurotic tendency, and self-sufficiency.

In general, the correlations found tend to be small and insignificant in size, in view of their probable errors. There are tendencies toward a relationship between achievement in archery, for the self-taught students, and height, weight, and previous experience in physical education. For the subjects given instruction, none of these factors has any significant relationship to achievement in archery. Two factors seem to have something more than a negligible bearing on success in archery when tuition is provided: general mental ability, and dependency or tendency to seek advice and encouragement from others.

CHAPTER V

ANALYSIS OF THE FLUCTUATIONS IN THE LEARNING CURVES OF INDIVIDUALS AND GROUPS

Introduction

Organization of the Chapter.- This chapter deals with five major topics, each in some way related to the general fact that performance in the course of learning archery does not improve steadily from shot to shot or practice period to practice period, but fluctuates throughout the time spent in practice. The general purpose is to analyze the fluctuations in the learning curves of both individual subjects and groups in the present experiment, with a view to determination of the facts as to variable performance, and their interpretation in the light of both factors in the experimental situation and general principles. The five topics may be listed as follows: (1) increase and decrease in score within single practice periods; (2) gain and loss in achievement from the end of one practice period to the beginning of the next period; (3) relation of achievement to a longer interval than customary between practice periods; (4) relation of achievement to participation in a competitive archery tournament; (5) correlations between achievement in archery of learners at various stages in their learning and their

general level of achievement in archery, and also between achievement at the beginning of practice and at its close. For each of these topics, comparative data are presented and discussed for subjects in the two groups of this study, the experimental group and the control group.

Increase and Decrease in Score within a Single Practice Period

Consistency and Variation of Score within a Practice Period.- Practice in a motor skill usually improves performance in that skill. It was of interest to see whether consistent improvement could be seen within the single practice periods of this experiment. To discover whether the score of each archer increased steadily within each practice period, a record was kept of the percentage score for each end of arrows shot by each archer.

The records of the individual archers for the ends shot during each practice period show wide variation. Some records show that the best score of the day was made with the first end of arrows to be shot. Some subjects made their best scores with the last end of arrows shot during the day. Still others made their highest score with one of the middle ends of arrows. Consistent increase or decrease in score within a single practice period could be seen in only a few of the individual records.

Method Used to Compute Increase of Score within a Practice Period.- To discover whether some advance in achievement could be found within a single practice period, the percentage score of the first end of arrows shot in any one day was compared with the percentage score of the last end of arrows shot on the same day. In order to clarify the procedure that was used, the record of subject H in the tuition group will be examined. With the first four days of this record as an example, the method for computing advance in achievement will be explained. The data are presented in Table XVIII.

On the first day of the experiment, March 18, two ends of arrows were shot. H made a percentage score of two on each of these ends. No progress or retrogression could be seen on that day. On March 23, three ends of arrows were shot. H scored thirty-one percentage points for the first end, thirteen for the second, and nine for the third end of arrows. On this day she retrogressed in percentage score.

On March 30, H's percentage score was twenty-two for the first end, thirty for the second end, and twenty-eight for the third end. While the percentage score for the last end was lower than that of the second end, it was higher than the score of the first end of arrows shot that day. Therefore, H was credited with gaining in score within the practice period of that day.

TABLE XVIII

PERCENTAGE SCORE OF EACH END OF ARROWS SHOT BY SUBJECT H IN THE TUITION GROUP DURING THE FIRST FOUR PRACTICE PERIODS

Date	Number of Ends Shot	Percentage Score for Each End	Change in Score within Practice Period
March 18	1 2	2 2	No Change
March 23	1 2 3	31 13 9	Decrease
March 30	1 2 3	22 30 28	Increase
April 1	1 2 3 4 5	37 59 61 55 48	Increase

On the fourth practice day, April 1, five ends of arrows were shot. Subject H made a percentage score of thirty-seven on the first end, fifty-nine on the second end, sixty-one on the third end, fifty-five on the fourth end, and forty-eight on the last end. Here again, H progressed from a first score of thirty-seven to fifty-nine and sixty-one points on the second and third ends. On the fourth and fifth ends, H's percentage score dropped. But since her score on the last end was higher than the score of the first end, H was considered to have gained in score during the practice period of April 1.

This same procedure was used for each of the eighteen practice periods that each girl shot. If the subject showed a gain within the practice period for ten or more of the eighteen days, she was considered as tending to gain in score during individual practice periods. If a girl's record showed that within the practice periods she gained in score on eight days or less, she was considered as tending to retrogress in score within the practice periods.

Increase of Score with Practice.- Table XIX and Table XX present data showing the variations in score made by the subjects of each group. These data show, as was to be expected, that the subjects in each group tend, on the whole, to improve with practice within a single period.

TABLE XIX

INCREASE AND DECREASE IN SCORE WITHIN SINGLE PRACTICE PERIODS FOR THE SUBJECTS GIVEN TUITION IN ARCHERY

Subjects	Number of Periods Showing Improvement	Number of Periods Showing Loss	Number of Periods Showing Neither Gain Nor Loss	General Tendency to Gain or Lose
Calvin....	7	10	1	Lose
Clark.....	8	10	0	Lose
Douglass..	14	4	0	Gain
Etherton..	7	10	1	Lose
Farlow....	15	3	0	Gain
Fisher....	10	7	1	Gain
Heatherly.	11	7	0	Gain
Huey.....	11	5	2	Gain
Johnson...	11	5	2	Gain
Jones.....	8	10	0	Lose
McCallum..	14	4	0	Gain
Mullinax..	7	9	2	Lose
Obermark..	13	5	0	Gain
Sager.....	12	6	0	Gain
Smith.....	9	7	2	Gain
Souther...	10	7	1	Gain
Thompson..	14	3	1	Gain
Wilson....	14	4	0	Gain
Wright....	10	7	1	Gain
Young.....	11	5	2	Gain

TABLE XX

INCREASE AND DECREASE IN SCORE WITHIN SINGLE PRACTICE PERIODS FOR THE UNINSTRUCTED STUDENTS IN ARCHERY

Subjects	Number of Periods Showing Improvement	Number of Periods Showing Loss	Number of Periods Showing Neither Gain Nor Loss	General Tendency to Gain or Lose
Baldwin.....	11	7	0	Gain
Cheney.....	9	8	1	Gain
Davis.....	9	9	0	No Tendency
Dennis.....	10	8	0	Gain
Freeberg....	5	13	0	Lose
Garrison....	12	5	1	Gain
Holmes.....	10	6	2	Gain
Homberg.....	12	6	0	Gain
Jackson.....	9	7	2	Gain
Konya.....	14	4	0	Gain
Laffoon.....	12	5	1	Gain
Mitchell, L.	8	9	1	Lose
Mitchell, T.	5	12	1	Lose
O'Rourke....	11	6	1	Gain
Rodeck.....	8	10	0	Lose
Russell.....	8	10	0	Lose
Spriggs.....	14	4	0	Gain
Tisdale.....	13	4	1	Gain
Wagner.....	14	4	0	Gain
Williams....	8	9	1	Lose

Fluctuations of Score within a Single Practice Period.- Fluctuations of score within a single practice period are common to all subjects in this study whether or not they are being instructed in the skill. While the general trend within each practice period is toward improvement, there is no consistency in this. The score of each successive end of arrows is unpredictable. In any succession of ends shot, the score of a subject may rise or fall, remain the same, or first rise and later fall. These fluctuations within a single practice period are seen in the scores made by the subjects in both groups.

Gain or Loss in Achievement between Practice Periods

Method of Tabulating.- In any study in which practice is spread throughout a number of periods, it is interesting to know whether gain or loss in achievement takes place between practice periods. In this investigation, a comparison was made between the score for the last six arrows (the last end) shot in any one practice period with the score of the first six arrows (the first end) shot at the next practice period. The scores might increase, remain the same, or decrease. The records for the seventeen periods between practice days were tabulated for each girl in each group.

Decrease in Score between Practice Periods.- Tables XXI and XXII present the data showing that most of the subjects taking part in this experiment had a tendency

TABLE XXI

VARIATIONS IN ACHIEVEMENT FROM THE END OF ONE PRACTICE PERIOD TO THE BEGINNING OF THE NEXT PERIOD FOR THE SUBJECTS GIVEN TUITION IN ARCHERY

Subjects	Number of Periods Showing Improvement	Number of Periods Showing Loss	Number of Periods Showing Neither Loss nor Gain	General Tendency to Gain or Loss
Calvin....	10	7	0	Gain
Clark.....	9	7	1	Gain
Douglass..	6	11	0	Lose
Etherton..	8	6	3	Gain
Farlow....	4	13	0	Lose
Fisher....	6	10	1	Lose
Heatherly.	7	10	1	Lose
Huey.....	11	6	0	Gain
Johnson...	6	10	1	Lose
Jones.....	13	4	0	Gain
McCallum..	4	11	2	Lose
Mullinax..	8	8	1	No Tendency
Obermark..	7	9	1	Lose
Sager.....	6	10	1	Lose
Smith.....	4	9	4	Lose
Souther...	8	8	1	No Tendency
Thompson..	4	10	3	Lose
Wilson....	1	14	2	Lose
Wright....	10	6	1	Gain
Young.....	7	10	0	Lose

TABLE XXII

VARIATIONS IN ACHIEVEMENT FROM THE END OF ONE PRACTICE PERIOD TO THE BEGINNING OF THE NEXT PERIOD FOR THE SUBJECTS UNINSTRUCTED IN ARCHERY

Subjects	Number of Periods Showing Improvement	Number of Periods Showing Loss	Number of Periods Showing Neither Loss nor Gain	General Tendency to Gain or Loss
Baldwin.....	4	12	1	Lose
Cheney.....	9	8	0	Gain
Davis.....	10	7	0	Gain
Dennis.....	8	8	1	No Tendency
Freeberg....	9	8	1	Gain
Garrison....	7	10	0	Lose
Holmes.....	9	8	0	Gain
Homberg.....	7	10	0	Lose
Jackson.....	5	10	2	Lose
Konya.....	5	11	1	Lose
Laffoon.....	7	8	2	Lose
Mitchell, L.	8	8	1	No Tendency
Mitchell, T.	10	6	1	Gain
O'Rourke....	6	11	0	Lose
Rodeck.....	8	8	1	No Tendency
Russell.....	9	8	0	Gain
Spriggs.....	2	13	2	Lose
Tisdale.....	7	10	0	Lose
Wagner.....	7	10	0	Lose
Williams....	9	7	1	Gain

to decrease in score from the last end of arrows shot at one practice period to the first end of arrows of the next practice period. The instruction given to the members of one group did not overcome their tendency to retrogress at the beginning of a new practice period.

Variation in Performance.- The individual records of both groups show that no student always lost or always gained in score between practice periods. The individuals sometimes improved, sometimes retrogressed, and sometimes remained the same. This variation in performance was common to members of both groups.

Comparison of Days of Practice.- The two groups each met on Tuesday and Thursday. This meant that there was a two-day lapse between the Tuesday and Thursday practice period; there was a five-day period between practices on Thursday and Tuesday. The records fail to show any consistent tendency to gain or lose related to the length of this interval. Since the students generally gained in achievement throughout the experiment, the scores each day were, in general, superior to the scores of the previous practice period (Figure 8, page 78).

Relation of Achievement to a Week's Cessation from Practice

Cessation of Practice during Holiday.- During the school's spring vacation period, which lasted from

April 21 to April 27, the students in both groups missed two regular practice periods. When the group records for April 29, the practice period following the holiday week, were compiled, they showed an interesting fact.

Tuition Group.- Previous to the holiday, the average achievement of the tuition class had reached a peak of fifty-seven points (Figure 8, page 78). This score had been reached after a series of rises without any drops for the group as a whole. After the week's holiday, the group score for the next practice period dropped back to fifty-five points. This was the first drop in score which this group had suffered from the beginning of the experiment up to that time.

Individual Records of the Tuition Group.- The individual records for each member of the tuition group show interesting variations following this holiday period (Table IX, page 92). On April 29, the first practice period following the vacation, twelve members of the tuition group made poorer scores than in the preceding practice period. One member of the group failed to gain or lose, and five members raised their scores. Two group members, who had started to show a regression in score before the vacation, raised their score after vacation, but still did not reach the mark of their previous high.

It is impossible to prove that the holiday caused the drop in score. But, as has been noted in Chapter III,

it is very probable that the twelve-day period during which no practices were held was an important factor in causing the scores of the tuition group to drop on the first practice day following the holiday.

Non-tuition Group.- In the non-tuition class, the score for the group on the day following the vacation remained at the same level it had reached previous to the holiday. The group score had started to fall on April 20. On this day the score dropped to thirty-seven points from the previous day's high of thirty-nine points (Figure 8, page 78). This first fall in score of the non-tuition group occurred at the class period immediately preceding the spring vacation. Following the vacation, the group score remained at this lower level for two periods, April 29 and May 4.

Individual Records of Members of Non-tuition Group.- The individual scores for the non-tuition group on April 29, the day following the week's vacation from school, show more individual variations than do those of the tuition group (Table X, page 96). Only one student in this non-tuition group dropped in score on this day from her high score of the period before. Nine of the students show a continuation of a drop in score already started before vacation. Four of this group made better scores following the holiday than they did before the holiday. Five girls raised their scores over that of the day previous to the

holiday, but did not bring them high enough to reach the levels they had reached at some previous time.

Comparison of Group Records.- The records of both groups show that following a week's cessation from practice no gain was made in average score. The non-tuition group, which had started to drop in score before the holiday, stayed at the same level it was before the holiday. The tuition group retrogressed in score following the week's cessation from practice.

Relationship between Achievement in Archery and the Incentive of Competing in a Tournament

Number of Tournaments Held.- In order to give added incentive for improvement to the members taking part in this experiment, tournaments in archery were held at regular intervals. Four tournaments were held in each class.

Number of Practice Days between Tournaments.- The first tournament was held on the fourth day of practice, which was April 1. This permitted each group to have three practice days before the first tournament. The next tournament was held on April 20. The third tournament was held on May 13, and the last one on May 27. There were four practice periods between the first and second tournaments; and four between the second and third tournaments.

There were three days of practice between the third and last tournaments; and three previous to the first tournament.

Number of Arrows Shot at Each Tournament.- During each of the first three tournaments, five ends or thirty arrows were shot. During the last tournament, which was held on the final day of the experiment, only three ends or eighteen arrows were shot. The reason fewer arrows were shot on the final day was that the instructor had promised to teach to the non-tuition group the form of archery which she had presented to the tuition group. In order to do this, the time for the tournament had to be cut short. The tuition group was allowed to shoot only eighteen arrows, in order to keep the number of arrows shot by the two groups equal.

Types of Competition.- During the practice period previous to the tournament day, the students were informed that they would compete in a tournament at the following class period. They were told that they were to compete against their own classmates in three different phases of archery. They were to see (1) which girl could hit the target the most number of times during the tournament, (2) which girl could achieve the highest score out of the arrows shot during the tournament, and (3) which one could make the most points with six consecutive arrows. The students were told that the records showing the achieve-

ment of each girl in each of these three respects would be reported to the class for them to see.

Tournament Records of the Tuition Group.- On the first tournament day, the tuition group gained in achievement. The group score rose on the day of the tournament from a score of thirty-one to a score of thirty-eight (Figure 8, page 78). This was a seven point rise in score, a gain of two points over the amount of gain made the previous practice day.

On April 20, the second tournament day, the tuition group continued to raise their score, hitting a high of fifty-seven points. Up to this time, the group had suffered no losses in average score.

On May 13, the third tournament day, the group showed a two-point gain in percentage score over the previous shooting period. But this two-point gain followed a previous loss in score, and just brought the group score up to the previous high of sixty points. Thus, although the group gained in score over the immediately preceding practice period, it did not raise its score to a new level of accomplishment.

On the last tournament day, May 27, the tuition group dropped in score one point below that of the previous practice period, in which it had reached its high for the total experimental period.

The records of the scores made by the tuition

group on tournament days show that on all but the final day the group raised its score over that of the previous day. The group shot fewer arrows on the final tournament day than on any other. The records of this group also show that most of the students increased their scores within each practice period. These two facts might account for the one point drop in percentage score made by the tuition group on the final tournament day.

Tournament Records of the Non-tuition Group.- The non-tuition group, on the first tournament day, raised its score two percentage points (Figure 8, page 78). This was not as great a gain as the class had made on two practice periods previous to this time, but it was a gain in total achievement over any that the group had made up to that date.

On the second tournament day, the group scores made the first drop of the experiment. The average score for the non-tuition group dropped from a high of thirty-nine points, made at the previous shooting period, to thirty-seven points on this tournament day.

The group score remained about at this low level for three more practice periods before it rose to forty-five points. On the third tournament day, the average group score dropped to forty points. This five point drop was the second drop in score that this group had suffered

since the beginning of the experiment.

On the final day of the experiment, the non-tuition group shot its last tournament. On this day, the average score of this group rose to the highest point it reached during the entire experiment.

The non-tuition group, then, gained on percentage score on two tournament days, and retrogressed in score on two such days. The first tournament day which showed a gain in score was during the initial stage of learning before either group had suffered a loss. The second tournament was held at the class period just preceding the spring vacation. The excitement due to the prospective holiday might, as was noted in Chapter III, account for this drop in score. Another cause for this drop in score might be the result of the pressure of competition upon imperfectly organized skill. The students in this group had not as yet mechanized their techniques, and under the pressure of competition these techniques broke down.

No apparent reason can be found for the drop in score made by the non-tuition group on the third tournament day. The gain in score made by this group on the last tournament day may be due to the impetus of a final practice period. By this time, skill in archery was relatively well organized; and the group had more assurance. Competition was no longer a strain, but became an impetus to

achievement.

From this record, it is impossible to make a conclusive statement regarding the relationship between achievement score and shooting a tournament for those who did not have instruction in the technique of archery. However, shooting a tournament did not greatly aid the non-tuition group to raise their scores during this experiment.

Correlations between Initial and Final Achievement, and between Achievement at Various Stages in Learning and General Achievement

Method of Comparing Achievement on First and Last Practice Periods.- To discover to what degree students retain their relative status throughout the course of learning archery, a comparison was made of the way in which students ranked on certain days.

The students in each group were ranked in achievement according to their score on the first practice day. They were again ranked according to score in the final practice period, May 27. The correlation was then computed.

Relative Status of Members of the Tuition Group on First and Last Practice Periods.- In the tuition group, the correlation between the scores made by the students on the first and last practice periods was -.17 (Table XXIII). The probable error of this coefficient is .15. This shows that practically no relationship other than one of chance

TABLE XXIII

CORRELATION OF SCORES ON THE FIRST PRACTICE DAY WITH SCORES ON THE LAST PRACTICE DAY FOR THE TWO GROUPS

Group	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition.....	-.17	-.17	.15
Non-tuition...	.46	.47	.12

existed between performance in archery on the first and last practice days.

The girls who had systematic instruction in archery shifted in relative rank from the first to the last practice period. It is probable that the constant tuition which the instructor gave to this group was one of the factors causing this change in rank. The girls who ranked highest on the first practice period did not retain their high status. The ranking of the students on the first day of the experiment showed very little about the way they would rank on the final day of the experiment.

Relative Status of Members of the Non-tuition Group on First and Last Practice Periods.- In the non-tuition group, the correlation between scores made on the first and the last practice days was .47 (Table XXIII). The probable error of this coefficient is .12. These figures show that the students whose scores were high on the first day tended to some degree to have high scores on the last day.

Since the members of this group learned mostly by their own efforts, without assistance from the instructor, it is not surprising that those who quickly acquired a usable technique continued to use this technique. They then were able, by making adjustments in their form as time went on, to keep the superiority they had achieved on the first

day of practice.

Index of General Achievement.- The average score of every girl for each of the eighteen practice periods was totalled and averaged. The subjects were ranked according to this average score. The rank thus obtained was considered to be the best index of the subjects' relative ability in archery. This was because it tended to nullify any single poor score which an archer made.

Data Obtained.- To see the relation between total achievement and achievement at various stages in learning archery, correlations were computed between general achievement and achievement at each of the following periods: first, ninth, seventeenth, and the eighteenth or last period of practice. Table XXIV presents the data on these correlations.

Comparison of Correlations for the Two Groups.- By examining Table XXIV, it can be seen that the correlations of the two groups vary in the same way. The students who ranked well throughout the whole experiment showed some tendency to superiority at the first practice period. This is highly marked for the members of the uninstructed group, but is noticeable to a smaller degree among the members of the instructed group.

On the ninth practice day, which is the one nearest the mid-mark of the experiment, the rank of the students

TABLE XXIV

CORRELATIONS OF GENERAL ACHIEVEMENT WITH ACHIEVEMENT AT VARIOUS STAGES IN LEARNING ARCHERY FOR THE TWO GROUPS

Group	Day of Practice	ρ	r_ρ	P.E.$_{r_\rho}$
Tuition	1	.33	.34	.14
	9	.81	.82	.05
	17	.67	.68	.08
	18	.48	.49	.12
Non-tuition	1	.61	.62	.09
	9	.75	.76	.06
	17	.74	.75	.08
	18	.63	.64	.09

most closely resembles the rank they assume for total achievement. On the last and next to the last practice period there remains a close relationship in rank, although it is not so clear as at the ninth practice period.

These data reveal that the scores at the mid-point of the experimental period can be considered the best indication of total achievement that can be secured at any one practice period.

The correlations for the non-tuition group are larger, at each stage of practice, than the corresponding correlations for the tuition group.

Summary

Great variations were found in the individual records of score in both classes. The scores of the members of both groups had a tendency to increase within a single practice period. However, while this increase continued throughout the experiment, it was unpredictable at any particular time. The scores of some students would rise and then go down, while others dropped and then went up. The instruction given did not overcome the tendency for fluctuations to appear in the performance of the individuals.

Most of the subjects tended to have a decrease in score from the last end of arrows shot at one practice period to the first end of arrows shot at the next practice

period. This tendency was common to members of both groups. However, no student always lost during the interval between practice periods. Variations in performance were seen here also.

Longer than usual cessation from practice seemed to affect the scores of both groups. Following a twelve-day holiday, the instructed group suffered its first loss in score, while the score of the uninstructed group remained at the same lowered level to which it had fallen at the practice period previous to the holiday.

Tournaments in archery seemed to have a different effect upon the two groups. For the subjects who had been instructed and who had learned to mechanize their skill, tournaments acted as an incentive toward better scores. But the pressure to do well under tournament conditions seemed to hinder the progress of the uninstructed group members, who took a longer time to mechanize their skill.

Tuition is apparently much more influential upon final status than is success or failure at the beginning of the learning process. For the uninstructed group, achievement at the last practice period could be fairly well predicted from the success at the first practice period.

There is some tendency toward relative rank between achievement at each period with the general rank of

achievement. The relationship is less marked at the beginning of the experiment and at its close or just before its close than at the middle part of the experimental period. All the correlations found were far from perfect with large individual fluctuations in relative standing among the different individuals. The non-tuition group members retained their relative status much more steadily than did those who were given tuition. Evidence to help interpret this fact will be given in the following chapter.

CHAPTER VI

FACTORS REGARDED BY ARCHERY STUDENTS AS RELATED TO THEIR OWN PERFORMANCE

Introduction

The main problem of this chapter is to analyze the factors in learning that were secured from data obtained from the learners, and from direct observation, but which are not obvious in the quantitative data reported in the other chapters.

Main Topics in the Chapter.- The main topics in this chapter are: (1) thoughts reported by students in the tuition group for the period while they were shooting their first twelve arrows; (2) thoughts reported by students in the non-tuition group for the period while they were shooting their first twelve arrows; (3) comparison of thoughts reported by the two groups; (4) techniques acquired by the members of the tuition group during the second, third, and fourth practice periods; (5) techniques acquired by the members of the non-tuition group during the second, third, and fourth practice periods; (6) comparison of techniques of the two groups; (7) stages in the learning of the tuition group; (8) stages in the learning of the non-tuition group; (9) effects upon learners of watching others of the

same ability; (10) reactions of the subjects to tuition; (11) analysis by the subjects of their losses in score.

Sources from Which Material in This Chapter Was Gathered.- At the beginning of the experiment, the students regularly wrote introspective accounts of the ideas that went through their minds while they were learning archery. They wrote such an account for each of the first eight practice days. The students thereupon reported that the thoughts that were going through their minds while they were shooting were the same ones day after day. The students reported that they had great difficulty writing these accounts. From the investigator's point of view, the reports were not very satisfactory. The students apparently felt that they ought to think about something while they shot, and consequently did. When they asked themselves what they were thinking, their thoughts began to dwell on thinking instead of upon archery. There were many periods during which the students believed that no thoughts went through their minds. They were not able to recall exactly the things that they had considered. Their thinking during the process of shooting seemed to be a hazy matter. When the students began to have great difficulty writing these reports and complained that they could not write them, the introspective accounts were stopped.

On March 25 and on April 8, printed questions,

given in Appendix, were handed to the students. The girls answered the questions in writing and turned their answers in to the instructor. From these answers, as well as from answers to certain questions uniformly asked at the time of the interviews, the students' thoughts about archery could be tabulated.

The observer, present in each class, recorded much of the conversation about archery that went on between group members during the practice periods. The non-tuition group members discussed their thoughts and feelings much more than did the members of the other group. The observer who recorded proceedings in the non-tuition group was especially capable. She was able to move around among the girls and record many of their remarks.

Immediately following each class period, the instructor wrote a report of the instructions given to each group. She also wrote down notes concerning interesting happenings which took place in class. The notes taken by the instructor were compared with the notes taken by the observers.

The material to be analyzed in this chapter was compiled from the above-mentioned sources, namely, (1) introspective accounts, (2) answers to set questions, (3) records of interviews, (4) records of class proceedings, and (5) the instructor's notes.

Thoughts Running through the Minds of Students in the Tuition Group as They Were Shooting Their First Twelve Arrows

Thoughts Concerning Archery.- The reports written by one girl naturally were very different from those written by another. The ideas each student had were different from the thoughts of another. The form or technique of shooting which had been stressed, and which the students practiced before they shot, concerned most of the students in the tuition group at one time or another during the first practice period. A few of the girls worried lest they might hit their elbows with the string. Some students thought about keeping their arrows from sliding off their bow hand. A thought which was general to a great many of the students was about aim. A few reflected upon how peculiar it was to aim at blocks on the floor in order to hit the target. A few wondered if they really were aiming correctly. Others just concerned themselves about hoping to hit the target.

Incidental Thoughts.- The thoughts incidental to learning archery that ran through the minds of some of the students were about tests in other subjects which they were going to take that day, and about letters they might get from friends out of town. A few students wondered about how well they would do in archery compared to other members of the group. Two students mused about whether

the teacher was watching them. Several thought about what fun archery was going to be and how they wished they could practice at home.

The reports showed that the students failed to keep their attention on any one subject. Thoughts ran or skipped through their heads. These thoughts may well have been part of their learning, yet were very difficult for the students to recall. There was a haziness about many of the conceptions.

Introspective Reports.- The introspective accounts of two subjects in this class are quoted in the following paragraphs in order to show the types of reports which were written.

Subject S:

How do I keep my arrow on my hand? Miss Davies said to make my hand level. Do I have everything as it should be? My elbow must be high. That block looks to be too far to the left. That arrow was too high and too far to the left. Are they watching me from behind? That shot was no good. I think I did not let the arrow go as I should have done. I wonder if Miss Davies saw that. That shot was pretty good. I either made a seven or a nine. I can pull this bow back with ease. Perhaps I should get a twenty-four pound one. I think I'll aim at that white line to the right of the block. Am I doing everything correctly? That aim was good. I will aim at that line again.

Subject D:

Is it my knockle or the tip of my arrow which is supposed to be on the white block? What a nice form she has. This one will probably hit the bull's eye by accident. I really would like to do this scientifically. After all, it is a skill. I wish the arrow would not slide around so much. This is really good exercise.

Main Points of Significance.- At this very first practice period in shooting, the students thought about the various parts of the technique with which they were having trouble. Many ideas not concerned with archery also ran through their heads. None of the students conceived any original ideas of her own about archery. Their concern about technique made them reflect upon and consider what had been told them. They did experiment with shifting their aims, but that procedure had been suggested to them.

Thoughts Running through the Minds of the Students in the Non-tuition Group While They Were Shooting Their First Twelve Arrows

Thoughts Concerning Archery.- The reports written by the non-tuition group showed more similarity than did those written by the other group. Every one of the non-tuition group was concerned about aim. Each wondered where to aim and how to aim. Very few showed much concern about the form they were developing.

Several girls worried about keeping their left elbows out of the way of the string. This was one part of the technique which had been emphasized by the instructor, because of its importance for safety. Several girls wondered whether they were pulling the string correctly, and whether they were pulling it back far enough. One girl wondered whether the arrow really would shoot when she let

go the string. Several pondered ways to keep the arrow from sliding off the bow hand.

Several girls were concerned with those around them. One girl noticed that the observer was taking notes and wondered what she was writing about her. Several more reflected self-consciously about themselves. One girl wondered if a squatting position of the body would help her hit the target, another wondered if nocking the arrow crooked would aid her to hit the target.

Introspective Reports.- The introspective reports of two of the students follow.

Subject H:

At first, I drew back and pulled. I missed the target completely. I thought then that I was not pulling hard enough. I then started thinking about hitting and aiming. I was more careful, and when the arrow hit the target it fell off. I thought, darn, no score at all. Then I remembered it was a score. I kept saying to myself, I've got to make this one a good one. My thoughts were not connected very well.

Subject M:

During the first end I wondered whether I should aim by closing one eye, and if so which eye. I also experimented with the distance of the pull. During the second end, I tried to decide whether or not I could do better by closing one eye, and which eye. This time I gave a lot more attention to the position of my left elbow. The girl standing next to me had scraped her elbow with the string.

Main Points of Significance.- At this first trial in shooting, the thoughts of the students who learned without the assistance of the instructor were mostly about aiming and hitting the target. Some of the ideas were

about experimenting with the pull, the body position, and other details of form which might help the girls to shoot. There was, however, as a whole surprisingly little reflection about the technique involved in learning archery. The main concern was aiming. The members of the non-tuition group seem to have concentrated upon the problem, but to have had a narrower range of definite details of the problem about which to think. Both groups reveal shifting attention as a main characteristic of mental activity during the first attempts at archery.

Thoughts of the Two Groups Compared

Tuition Group.- Students learning archery assisted by an instructor thought, during the first practice period, about the parts of form which they had been taught, and with which they were having trouble. They were concerned about the errors which the instructor had pointed out to them. These students also considered many extraneous matters while they were shooting. They did little in the way of experimental problem solving.

Non-tuition Group.- At the first practice period, students who learned archery by their own efforts thought mostly about where they should aim to hit the target. They were also concerned about the different techniques with which they were experimenting in order to

find something which would help them in their final performance.

Techniques Acquired by Members of the Tuition Group during the Second, Third, and Fourth Practice Periods

Introspective Accounts.- The introspective accounts from the students in the tuition group during the second, third, and fourth practice periods continued to show great variety. There was noticeable, however, a sameness running through each individual's consecutive accounts of her own thoughts. The individual tended to repeat the same ideas; but these were different from those of the other members of the group.

During the second practice period, a few of the students recalled that no ideas at all went through their minds while they were shooting some of their arrows. Most of the students, at some time during the period, recalled the individual instruction the teacher had given them. This, and concern about changing the aim, were common to all students. They continued to attend to the form that had been presented to them.

Answers to Questions.- Following the third practice period, the students answered questions which had been prepared by the instructor. Each archer said that she enjoyed the sport. Eighteen said that they felt tense

while they shot. Eighteen thought that they kept their attention and thoughts on archery while they shot. Fifteen of the girls claimed to be working and concentrating on a particular phase of the technique of archery. Eighteen said that they understood aiming.

Technique Acquired.- By the fourth practice period, all of the students had approximated the technique being taught to them. Photographs of the students were taken on this day. While these photographs show deviations from the form being taught, the general technique used by the girls was the same. One of the photographs taken on April 1 is shown in Figure 11.

Variations in the Technique of Seven Students Photographed on April 1.- Numbering the students in the picture one to seven from left to right, the similarities in technique can be noted. All but number five closed their left eyes while aiming. All had their feet slightly apart, left sides toward the target, and weight evenly distributed on both feet. Each drew so that the string touched her chin and nose. All had their right elbows higher than their shoulders.

The variations from the technique taught are as follows: Number one hunched her left shoulder, lifted her chin, had her feet not quite parallel, held the upper part of her body tense, and had a tight grip upon the bow.

Figure 11.- Members of the tuition group on April 1, at the fourth practice period in archery.

Number two pushed her left shoulder toward the string, tensed the upper part of her body, and lifted her head slightly. Number four drew the string to an anchor point above her chin. Number five drew the string to a spot below her chin, and turned her left elbow quite far away from the line of her body. Number seven pushed her left shoulder toward the string, and held the upper part of her body tense.

Even noting the variations in the techniques used by the different girls, the general form was quite close to that which they would acquire by the final weeks of practice. A picture of the same girls taken on May 25 is shown in Figure 12.

Technique of the Seven Students Photographed on May 25.- Subject number one had her feet parallel, lowered her head, relaxed her shoulders, and loosened her grip on the bow. These errors she had corrected since April 1. Changes appearing in the form of the other six girls since the photograph of April 1 are as follows: Subject two relaxed her left shoulder and upper part of her body, and lowered her head. Number three had almost the same form she had on April 1. This girl made fewer obvious errors on the earlier date than any of the other girls shown in the picture. She had the third highest score for the entire experiment. The fourth girl lowered her head and the hand that drew the string. The fifth girl brought

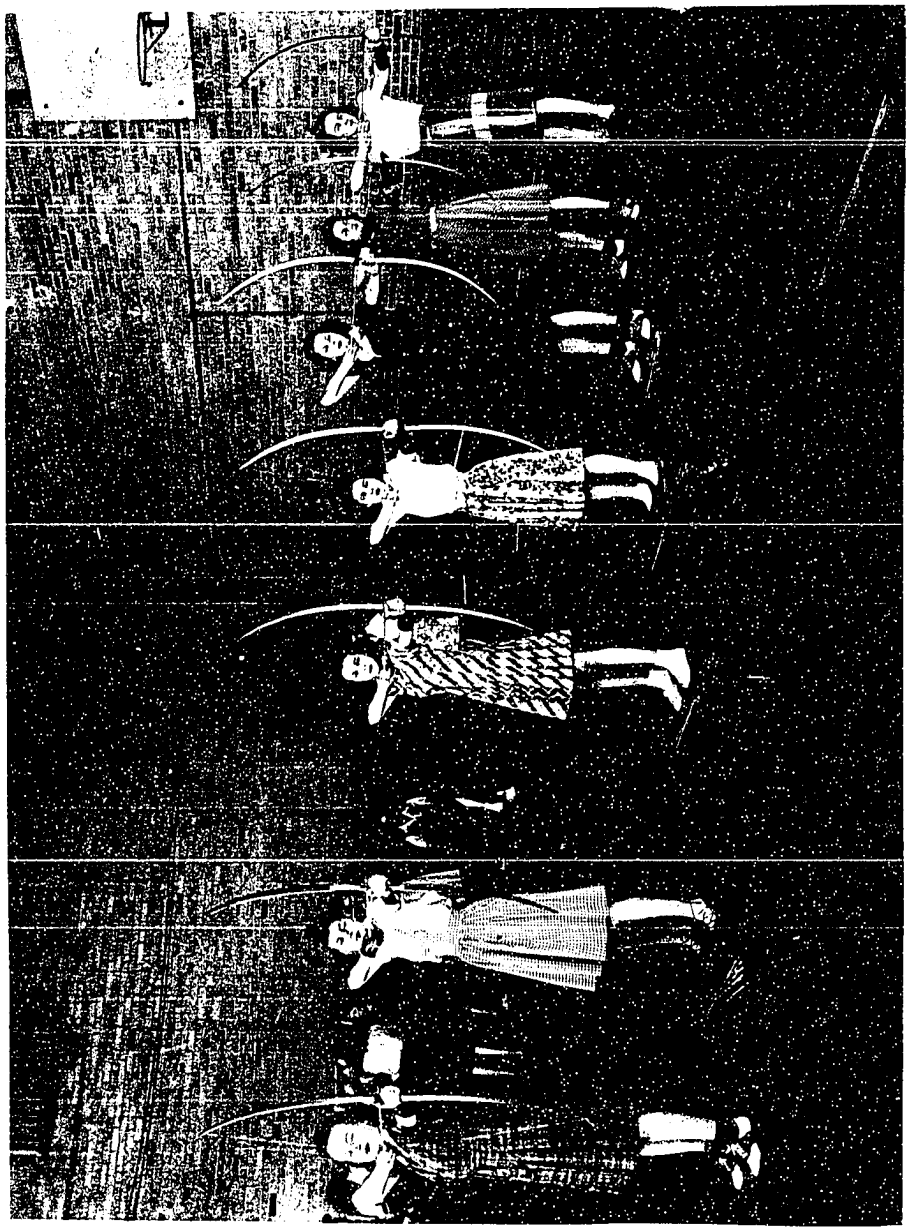

Figure 12.- Members of the tuition group on May 25, at the next to the last practice period in archery.

her right hand up to touch her chin, and acquired a less awkward position of the elbow of her bow arm. Number six lowered her head and loosed her bow grip. Number seven relaxed slightly from her posture at the time of the earlier picture.

Main Findings.- The members of the tuition group during the second, third, and fourth practice periods still worked on the individual faults which the instructor had told them about, but were beginning to be more concerned about aim than they had been. They also began to have periods during which no thoughts or ideas seemed to pass through their minds as they shot. By the end of the fourth practice period, the students had acquired, in the main, the technique they were trying to learn, and which they continued to try to perfect until the final practice period.

Techniques Acquired by Members of the Non-tuition Group during the Second, Third, and Fourth Practice Periods

Introspective Accounts.- The introspective accounts of the thoughts of the students in the non-tuition group show that during the second, third, and fourth practice periods the group members became more concerned with the form of archery than they had been on the first day of practice. The group members were

still pondering about their aim. Some of the students had decided to aim with their left eye, some with their right, and one girl closed both eyes just as she released the arrow. The students considered the methods they used to release the string. They considered the number of fingers they should use to pull back the string. They noticed the techniques used by others in the group, wondered about them, and tried different methods.

Answers to Questions.- All of the students in this group said, on March 25, that they enjoyed archery. Seventeen of them felt tense while they shot. Seventeen said that they believed they kept their thoughts mostly on archery while they shot. Fourteen were working chiefly on learning to aim, and fourteen said they did not understand aiming.

Form Acquired by Six Students Photographed on April 1.- By the fourth period the students had developed the form each had used to shoot her first arrows. Only minor changes had been made in the original technique used by each girl. Figure 13 shows a picture of six of the students in full drawn position, ready to release the arrows. This picture was taken on April 1.

Numbering the students from left to right in the picture, the variations in technique each employed can be discussed. Number one had her weight mostly on her left leg, pulled the string to a point below her

Figure 13.- Members of the non-tuition group on April 1, at the fourth practice period in archery.

shoulder, twisted her body toward the target, held her arrow between thumb and index finger, turned the elbow of her bow arm in, and pulled the string back only a short distance. Number two had her side toward the target, her feet parallel, pulled almost the full length of her arrow, held the arrow between index and middle finger, and had the elbow of her right arm slightly below her shoulder. The third girl pulled her string back two-thirds of the distance of the arrow's length, drew to a distance slightly in front of her face, held the arrow between index and middle finger, and raised her head to look over her hand. Number four turned her body toward the target and pointed her left foot slightly toward the target. She sighted down the arrow as though she were shooting a gun, held her arrow with her index, middle finger and thumb, dropped her right elbow, turned her left elbow in, and drew back about two-thirds the distance of her arrow. Number five twisted her body toward the target with feet not parallel, drew with her right elbow down to a point close to the front of her left shoulder, and held her arrow between thumb and index finger. Number six had her feet parallel, and drew her bow about three-quarters of the distance back to a place about eight inches below her chin. She held her arrow between index and middle fingers. She had most of her weight on her left foot. All of the students kept both eyes open while

they aimed.

Technique Used by the Six Girls on May 25.- Figure 14 shows a photograph of the same girls taken on May 25. These girls had made alterations in their technique of shooting, but were still using essentially the same method they had started with, except for girl number four.

All of these girls still aimed with both eyes. Number one still had most of her weight on her left foot and pulled the string to about the same distance below her shoulder, but pulled it much farther back than at the time of the other picture. She no longer twisted her body toward the target. She held her arrow in the same manner, and still had her left elbow turned in toward the body. Number two changed the position of her right hand and elbow. She raised her hand to a spot on a level with her nose, and sighted down the arrow. She now held her right elbow high. This girl kept changing the position of her right elbow. Even during the last week of shooting, she sometimes pulled with her elbow high and sometimes with it low, even though she pulled the string to a spot high on her face. Number three kept her position almost the same as on the fourth day, except that she raised her head higher and touched her chin to her hand. Number four, who did more figuring about methods of shooting than almost anyone else in the class, changed

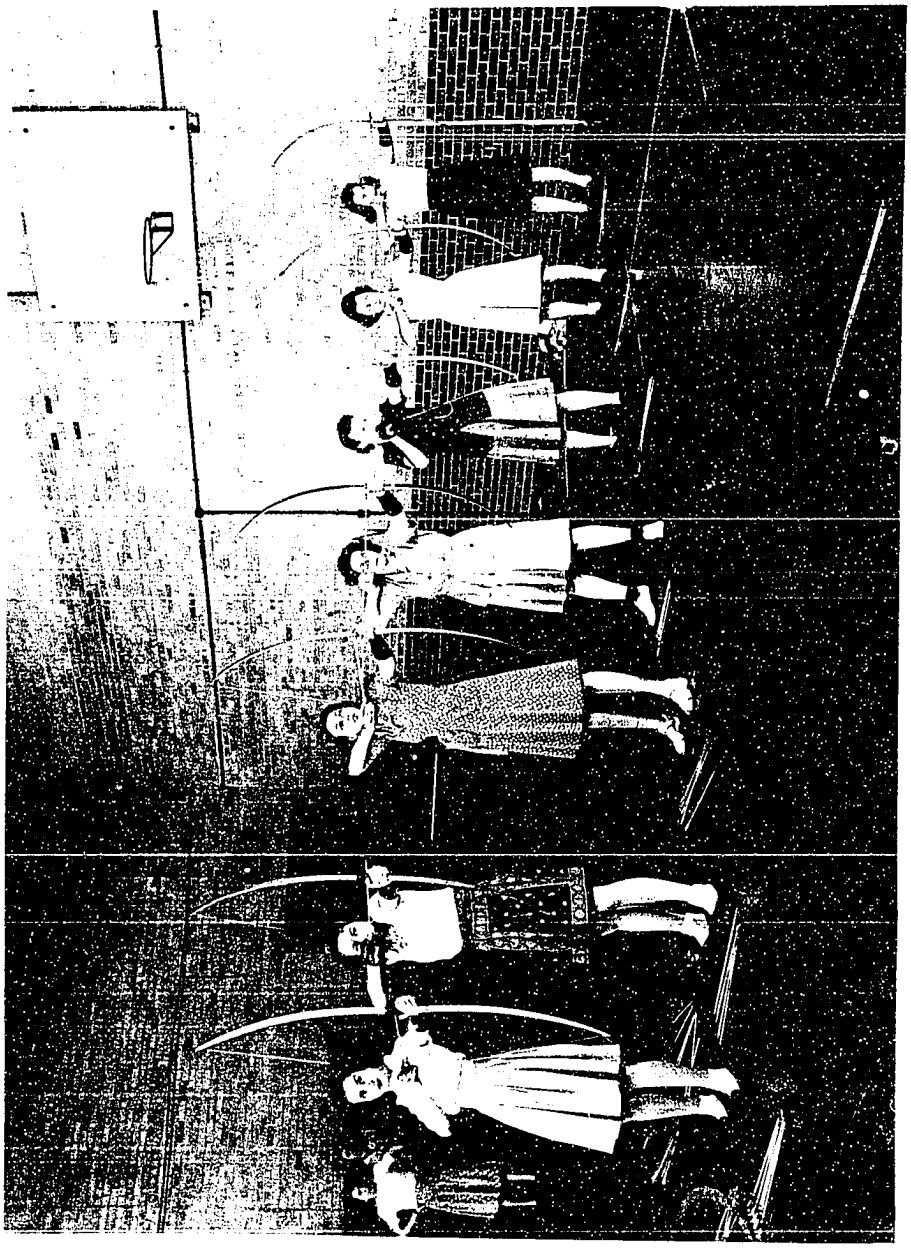

Figure 14.- Members of the non-tuition group on May 25, at the next to the last practice period in archery.

her position the most during the experimental period. She turned her body so that her left side was almost squarely toward the target. She raised her right arm, and pulled the arrow to the level of her eyes. She no longer touched the arrow with her thumb, and she learned to draw the arrow to a full-drawn position. Number five kept the same position she had on April 1 except that she drew her arrow farther back. Number six changed to put her weight on both feet, and raised her right hand to a position about five inches higher than she had raised it originally.

Techniques of the Two Groups Compared

Flexibility of Groups.- Although both groups had attained an approximation of their final form by the fourth practice period, the members had achieved this technique in different ways. The tuition group was much more flexible in acquiring form. The members allowed themselves to be changed by the suggestions of the instructor. They were willing to change their form, although it might mean temporary loss in performance, in order to be better archers at a later date. They concentrated on what the instructor had told them. The students in this group at that time had many periods during which their minds seemed to be blank while they

were shooting.

The members of the non-tuition group were much less flexible than the tuition group while they were learning to shoot. Having acquired a fairly successful form, the students in the group kept that technique and worked upon aim. They were unwilling to experiment with a form which might lower their scores.

The difference in the flexibility of the two groups was again noted at the end of the experiment. After the final arrows had been shot in the experiment, the non-tuition group was taught the form which had been presented to the tuition group. The instructor demonstrated and explained the technique; and gave manual assistance to the students who had difficulty acquiring the position. The non-tuition group members then used this form as they shot a few ends of arrows.

Each group had one more class period to attend after the last day of the experiment. At this final class meeting, both groups were taken outdoors and given the experience of shooting from different distances. At that time, all of the members of the non-tuition group except three went back to the technique each had developed instead of using the one which the instructor had drilled them in at the end of the previous class meeting.

Trial and Error.- Trial and error was used by both groups. The non-tuition group was forced to experi-

ment and try out techniques which the members wished to acquire. The tuition given to the other class eliminated much of the trial and error which the non-tuition group went through, but the instruction given did not eliminate all trial and error. The introspective reports indicate that the students in the tuition group pondered the tuition given, but had to experiment with it before they were able to assimilate it as a part of their own technique. However, in the non-tuition group, the subjects reverted to their early and moderate successes by reducing the range of their variations in technique. The tuition group experimented little. The errors made by this group were due more to inability to follow instructions completely than to conscious efforts to change their procedure or to improve. They were quite willing to change their behavior when so instructed.

Stages in the Learning of the Tuition Group

First Stage of Learning.- The tuition group seemed to go through four stages in their learning during this experiment. In the first stage of learning, the girls thought about the form which had been taught to them. They also tried to learn where to aim. The introspective accounts show that many thoughts ran through the students' minds. The thoughts about archery

form and point of aim predominantly recurred during this period.

Second Stage.- These students entered the second phase in learning after they had mastered the rudiments of the skill. At this time, the students began to think less about form and more about aim and score. The introspective accounts show a sameness in the thoughts of any single archer. The students had many periods during which they could recall no thoughts at all going through their minds as they shot. During this period, the students said they paid very little attention to the group instruction which the instructor gave. They only corrected their errors and concentrated on their form when the teacher corrected them individually. They wanted to practice what they already knew.

Third Stage.- The third stage is a less clearly defined one. In this stage, the students began to realize that good form in archery was essential to good scores. They sought individual correction. They wanted to know the reason that the arrow made each deviation from the expected course. They became perfectionists. They again became conscious of the form they were using. They went over, piece by piece, all the instruction the teacher had given, to see that they were performing each act correctly. Eighteen of the girls in this group analyzed their shots. Only two did not. Of the eighteen,

seven analyzed only their good shots while eleven analyzed each shot whether good or bad. The analysis made by students was to figure out what they had done which caused the arrow to hit where it did. The errors they reviewed were those which the instructor had previously mentioned. Observation of this stage of learning indicated that the students were well able to analyze most of their own errors.

Fourth Stage.- The fourth stage of learning for members of this group was an advanced stage. By this time, the archer had almost perfected her form. It had become mechanical. She had learned to hit the target with every arrow. Her aim became to group her arrows in the center ring of the target face. At this time, the archer concentrated entirely on her point of aim. The students said that they thought of nothing except the spot at which they were aiming. Any other thought distracted them. They were no longer conscious that there was anyone else near them.

Students taught in a class seem to reach each of these stages at different times. If all students went through these stages of learning at the same time, it probably would have had a marked effect upon the group learning curve.

Shifting Attention from Part to Entire Skill.- Students in this group were asked on April 8 whether they

learned by concentrating on the whole act of shooting, or whether they learned by concentrating on each separate part of the skill. The answers were equally divided between the two methods. Ten students said they worked on each part of the technique separately, and ten said they thought of the whole act while they were shooting.

During the last few weeks of the experiment, the same question was asked. Eleven of the students reversed their earlier decisions as to whether they worked on each part of the skill separately or worked on all parts at once. Six of the ten students who in April said they learned by concentrating on each part separately, now said they learned by concentrating on the whole act of skill. Five of the ones who earlier thought they learned by thinking of the whole act of skill, now thought they learned by working on each part of the technique separately.

Main Points of Significance.- Students being taught archery went through four stages in learning. During the first and third stages, they broke the skill into its component parts, and worked on each part separately. During the second and fourth stages, they worked on the entire skill.

Thus, in this investigation it seemed that learning a motor skill under tuition took place by shifting attention from an analytical concentration upon com-

ponents of the technique to the Gestalt idea of the total picture of the skill.

Stages in the Learning of the Non-tuition Group

Main Interest of the Group.- The students in the non-tuition group did not seem to go through the four phases noticed in the learning process of the tuition group. This class was mostly concerned with aim from the beginning of the experiment to its end. The introspective accounts show the great amount of time spent thinking about aim. Aiming and hitting the target took up more of the thoughts of this group than did figuring out methods of improving their technique. It was only when the girls found that they were unsuccessful in their shooting that they thought about improving their technique.

Excitability of this Group.- Throughout the first few practice periods the members of this group displayed a nervous and frustrated attitude while they were shooting. They were upset. This was probably because they were striving to achieve a good score, but did not know how to go about doing this.

Answers to Questions.- The same questions were asked of the members of this group as were asked of the other group. The members of this group attributed most of their poor shots to a bad aim. Next to lack of abil-

ity to aim, most of the girls in this group thought their greatest fault was a poor release. Only one student in this group said she did not analyze her shots. Of the nineteen who did analyze their shots, nine analyzed only their misses and ten analyzed every shot they made. The analysis of errors made by these subjects was poor. They attributed almost all of their poor shots to bad aim or poor release. They rarely realized that they failed to be consistent in their form, and that their aim could not compensate for these other errors. The observer writing down their conversation many times noted that the students discussed the fact that their arrows did not go where they aimed them.

Experimentation with Technique.- The students in this group did not try out as many different solutions to their problems as the instructor had expected them to. Only a few of the group members developed a technique of shooting by figuring out causes of deviations of the arrow. Instead, the girls continued to use the first method with which they had had any success. They made small adaptations in this method from time to time.

Only two or three members of this group ever became proficient enough in the skill to hit the target with almost every arrow. Therefore, these students never reached such an advanced stage of shooting that they could put all their attention upon making small ad-

justments in aim in order to group their arrows in the gold.

Superiority of One Student.- One student in this group was far superior to the other members of the class. She did become good enough so that she could work on shooting her arrows into the gold. She attributed her misses to lack of attention. She said that when she tried she could make her arrows go where she wanted them to. If she relaxed her attention her arrows flew away from the spot to which she wanted them to go. This may indicate that this girl had reached a stage of learning in which she concentrated only upon aim. She said she never thought about her form at all. She also said that if she did think about a part of the skill, her performance was not so good as it had been.

Explanation of Learning in this Group.- The members of this group did not follow the same sequence of learning as the members of the tuition group, since this sequence involves analysis and synthesis for which the uninstructed subjects lacked the necessary insight.

Shifting of Attention from Part to Entire Skill.- On April 8, the students in the non-tuition group were asked whether they concentrated on each separate part of the technique, or whether they gave their attention to the whole act of shooting. The answers were equally distributed between the two methods. The answers to the same

question asked about a month later revealed that these students, as well as those in the tuition group, had changed their minds about the way in which they learned. Six who earlier said they learned by concentrating on the whole act, now said they learned by working on each phase of the technique. Five who in April said they worked on each part of the skill, in May said they worked on the entire skill at once. These students also learned by letting their thoughts and attention vacillate back and forth from the parts of the skill to the whole act of shooting. The student would concentrate on that part of the skill in which she believed herself deficient. Most of the time, the students thought they were deficient in their ability to aim. When a girl was shooting well, she ceased to think about the individual parts of the skill.

Main Findings.- This group showed considerable excitement and agitation during the first practice periods. The analysis that these students made of the reasons their arrows went where they did pertained to aiming rather than to technique. The students in the non-tuition group thought of form only when they were not being as successful as they thought they should be; and their concentration upon aim had not helped them.

The Effects of Watching Others of the Same Ability

Previous Findings.- In Lashley's experiment [1] with archery, he found that his subjects, who learned without tuition, did not gain from watching others shoot. He decided this from observational records of the different types of form used by the various subjects.

Cozens, [2] experimenting with instruction in track and field activities, found that his men learned little from watching others.

The students in this present investigation were asked whether they thought they learned much from watching others in their group shoot.

Tuition Group.- The majority of the students taught by the instructor thought that they learned very little from watching others of their own ability shoot. They looked at the other archers and noted their faults, but did not apply much of their observation to themselves.

The students in this group watched the other

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[1] K. S. Lashley, "The Acquisition of Skill in Archery," Carnegie Institute, Department of Marine Biology Papers, Vol. VII, pp. 105-128. Washington, D. C.: Carnegie Institute of Washington, 1915.

[2] Frederick W. Cozens, "The Determination of the Efficiency of Group Learning under Different Incentive Conditions and Modes of Activity," American Physical Education Association Research Quarterly, IV (May, 1933), 50-62.

group members while they waited their own turn to shoot, but they did not talk among themselves as much as did the other group. The students concentrated on their own faults. They talked to each other about their scores rather than about their technique. They seemed much more intent and serious than did the members of the non-tuition group. They were also much quieter during the practice periods than were the members of the other group.

When the photographs taken on April 1 were brought to the tuition group, the girls were quite interested. The instructor pointed out the faults which showed in the pictures, and told how these could be corrected. The students who had committed the faults, and about whose pictures the instructor commented, seemed to learn quickly from this type of instruction. Each individual learned from looking at the picture of herself. Little interest other than idle curiosity was shown by the students in the pictures of their classmates.

Non-tuition Group.- Many of the students in the non-tuition group acknowledged learning from watching others in their class. They watched the girls who made the highest scores, and tried to imitate their technique. The students in this group talked a great deal while they were waiting for their turn to shoot. They discussed archery, the form used by the different girls, the scores, and the reasons that the arrows failed

to go where they were aimed. They compared the technique one girl used with that used by another. They discussed the good and bad points of each girl's performance, as they saw them.

Several students in the non-tuition group reported to the instructor that they tried the methods used by others in the group; but found that those methods were not as successful for them as they had hoped they would be. Therefore, they went back to their own techniques of shooting.

From the many different types of technique acquired by the students in the non-tuition group, the instructor concluded (1) that their powers of analytical observation and their ability to imitate in archery were poor, and (2) that they were not willing to sacrifice temporary losses in score in order to acquire what was, for others, a successful technique.

The students in the non-tuition group were quite surprised to see their own photographs. A few of them could scarcely believe that they looked the way the photograph pictured them. These photographs were not shown to this group until after the final ends of arrows had been shot in the experiment. The reason for this was that the instructor did not want the students to be able to see their own faults and compare them with those of others in the group. This would be a form of visual

tuition which the students would not have acquired through their own powers. This group, then, did not during the experimental period have the opportunity to profit by the photographs of themselves taken earlier in the season.

Summary.- From observational records, and the students' own reactions, it was apparent that the students who were being systematically instructed in archery learned very little from watching their own classmates shoot. The students in the non-tuition group said that they did learn from watching others shoot. However, observation of their differences in form leads the investigator to believe that the students did not learn much from watching others; or, if they learned something from watching others, they did not apply their knowledge to their own technique.

The Reactions of the Subjects to Tuition

Immediate Effect of Tuition upon the Individual Group Members.- It was noticed that while the instructor stood next to a girl to give her individual instruction, the girl's performance in the skill became poorer. During interviews, each girl was questioned regarding the immediate effect of instruction upon performance.

Twelve of the students said that their perform-

ance was hindered at the time the instruction was being given. Some of the students attributed this to nervousness at being watched. Nine students said that, when they concentrated on correcting one part of the technique, they always made poorer scores.

The students were asked if correcting one fault made them commit another one. Thirteen of this group said that it did not. They could work on one phase of the technique without having it affect the rest of the technique. Six students thought that correction of one fault was likely to make them commit another fault. One girl did not know whether it did or not.

Desire for Individual Correction.- All the girls in the group but one wanted the instructor to give them individual attention. The one exception said that she preferred to be let alone. She wanted to try out some of her own ideas. She also said that she felt that everything she had done was wrong if the instructor corrected her. The instructor continued to give instruction to this girl as well as to the other members of the class. After the first four practice periods, the one girl who had resented the instruction changed her mind regarding it. After that time, she wanted her faults corrected as much as the other members did.

Kinds of Tuition Given.- The tuition group was given several types of instruction. The members were

given manual help. The instructor did this by holding the arms of the student in the correct position while the student shot. Also, the teacher sometimes put her finger on the arrow to hold it in position next to the bow before it was shot.

Verbal instructions were given to the whole group whenever a new technique or part of a technique was presented. The instructor also demonstrated the new technique. Visual aid was also given by permitting the students to see pictures of nationally-known archers, and photographs of themselves.

Individual instruction was given throughout the class period. This usually took the form of verbal correction and explanation. Sometimes, this took the form of demonstration or manual assistance.

Types of Instruction Which the Tuition Group Thought Helped Them Most.- Six of the students in this group said that they thought that correcting their individual faults helped them the most. Five said that demonstration plus correction of individual faults was of the most value; three said that explanation helped most. Two students said that a combination of explanation and correction of individual faults was most helpful, one that demonstration was best, and three thought that demonstration plus explanation plus individual correction was best for them. From this, it can be seen

that sixteen out of the twenty thought that individual correction, either with or without another method of instruction, helped them the most.

The answers to this question indicate that students considered learning archery an individual matter. Many of them said they paid little attention to class instruction. For this reason, it seems advisable to keep archery classes small. In this way, individual help can readily be given to each student.

Types of Assistance Wanted by the Non-tuition Group.- The students in the non-tuition group were asked to write down the type of instruction they would like to have in archery. Five of these girls said they wanted instruction in aiming, five said they did not want any instruction, and four wanted individual correction of faults. Two students in the group wanted more practice than they were permitted during class periods, one wanted demonstration of techniques, and one wanted demonstration and correction of individual faults. Two students did not answer the question.

The answers to this question might have been different had the students known all of the types of assistance that might have been given. They may not have realized that the instructor could give them manual assistance. They may not have thought of the help which they could have received from reading about the sport in

books, and from looking at pictures of famous archers.

Findings about the Reactions of Subjects to Tuition.- The members of the tuition group wanted to have their faults corrected. They were able to work on the skill piecemeal without having that make them commit other errors. However, concentration upon part of a technique, as well as concentration upon the instructor's individual corrections, hindered the performance of most of the students. This group found that individual instruction was the most helpful of all the methods used.

Most of the non-tuition group thought that they would have progressed faster if they had had instruction in the technique of the sport. These students, however, did not have a clear idea as to what type of instruction would help them most.

Analysis by the Subjects of Their Losses in Score

Possible Causes for Losses in Score.- In Lashley's experiment in archery made outdoors with no attempt to control wind, temperature, and the like, he attributed the daily fluctuations seen in the learning curves of his subjects to chance, wind, temperature, fatigue, and tightness of bow. [3] Cozens attributed drops in performance to

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[3] K. S. Lashley, op. cit., pp. 105-128.

participation on cold raw days. [4]

This present investigation was carried on in a gymnasium in order to avoid the effects of some of these factors. There was no wind. The temperature varied for the non-tuition group from sixty-two degrees to eighty-five degrees during the experiment. In the tuition group the temperature varied from fifty-six to eighty-one degrees.

A list of possible causes for the losses in score was made and given to the students during their interviews. The students were asked to check any of the causes that they thought applied to them, and to add any other reasons they wished to. Following is the list of possible reasons for score losses that was handed to each student:

1. Lack of attention and effort
2. Trying too hard
3. Tension
4. Physical feeling
5. Mental feeling
6. Noise, temperature
7. Degree of difficulty of the skill
8. Attention to detail of the skill
9. Lack of motivation
10. Lack of interest

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[4] Frederick W. Cozens, op. cit., pp. 50-62.

11. Chance

More Than One Cause for Loss in Score.- The instructor discussed these reasons with each student. As the student talked, the instructor wrote down the reasons that the student thought influenced her losses in score. From this conversation, the instructor received a better idea of the student's thoughts about her periods of retrogression in score than could have been secured from a check list alone. Most of the students listed more than one reason, and some students listed four or five reasons which they thought had caused their drops in score.

Reasons Given by Tuition Group for Losses in Score.- Eight students listed attention to a particular detail of technique as one of the factors that made their score in archery fall. Seven students said that they shot more poorly at those times when they tried too hard to do well. These students mentioned that after they had shot about four arrows which hit the gold or red circles on the target face, they would try hard to put the next arrows in the same scoring circle. Almost always these next two arrows would go quite far from the center of the target. It was of interest to note that during this experiment no girl ever shot a perfect score of fifty-four points for one end of arrows. Fifty-two was the highest score made during any single end shot.

Seven students attributed daily fluctuations to

physical feelings. They thought that on days when they felt bad they did not shoot well. The instructor and observer noted, however, that on several days when students came to the instructor to tell her they felt bad and to attribute the poor score they would probably make to this fact, they did not actually make poorer scores. In fact, their performance was often the best it had been up to that time. The student was always surprised at this. The fact that many students shot better during times when they felt bad might be attributed to the fact that they did not care whether they did well or not. Therefore they relaxed and shot automatically. If they had already learned the form of the technique sufficiently well, their performance was good.

Six students said that they slipped back on days when they did not pay attention or put forth much effort to do well. They said that when their minds wandered to other thoughts, their arrows would go astray. Six students said they did badly in archery when they felt tense. These students were in general the same ones who said their scores dropped when they tried too hard.

Six students said they had poorer scores on days when they felt "low" mentally. Some of them said that they had these periods of depression for no apparent reason. Other girls gave as causes of their depression the fact that it had been a gloomy day, or that they had

done badly in another class, or that something had "gone wrong" that day.

Three students said they had drops in score within a single practice period at those times during which they thought other students were watching them shoot. Three students said their performance was poorer when they tried to hurry. One attributed her losses to poor aim, one to over-confidence, one to being discouraged, one to the fact that the room was warm, and one to chance.

None of the students attributed their losses to lack of motivation or lack of interest. All of the students said they were very interested in improving their score and tried hard each time. The varying degree of difficulty did not seem to be the reason for losses in score. Some of the students said that they were getting to the place where improvement was harder because it depended upon such fine adjustments in aim. They thought that this might cause them to stay at one level of score, but they did not think it caused drops in their score.

Reasons Given by Students in the Non-tuition Group for Losses in Score.- Students in the non-tuition group were presented with the same list of causes for score losses as had been given to members of the other group. They were asked to check the reasons they had drops in score, and to add any other reasons they wished. They, then, discussed their answers with the instructor.

Eleven of this group attributed their losses to the fact that they felt bad at different times. Eight said that they did less well on the days when they felt tense. Eight attributed losses to lack of attention and effort, and five to nervousness at being watched. Five said they did badly on those days when they felt mentally depressed. Three students said their performance became poorer when they tried too hard, three said attention to details hindered them, and two said they did badly when they were discouraged. One girl attributed her drops in score to poor form, and one to the fact that she sometimes hurried.

Comparison of the Analysis of the Two Groups.- With one exception, the reasons given for losses in score by the two groups were similar. The one exception, however, is the one which distinguishes the one group from the other. The reason for losses in score listed most often by the members of the tuition group was attention to a detail of the technique. Only three members of the non-tuition group considered this a reason for their drops in score. This difference is logical, because the tuition given to the one group made them conscious of the parts of the skill being taught, while the non-tuition group paid attention to details only when the members could think of no other cause for their failures.

Members of both groups listed as one of the main reasons for losses in score the feeling of tension

and trying too hard. Both groups listed days when they physically felt bad as times when their scores dropped. Observational reports, however, indicate that the students were not good judges of this. When the students felt bad, they lost their perspective; and they thought they were doing badly when, in reality, they were not.

Lack of attention and effort, and a psychological feeling of depression, both ranked fairly high in the statements of both groups as to causes for setbacks in score.

Summary

Sources.- The sources from which material in this chapter was gathered were introspective reports of students, answers of students to questions, reports of interviews with the students, reports by observers, and notes by the instructor of class happenings.

The data presented in this chapter are non-quantitative and complex. To clarify and synthesize the interpretation of these materials, the following somewhat extended summary is provided.

Summary.- While shooting their first arrows, most of the members in the tuition group thought about some part of the technique they had been taught. They also were concerned about aim. The thoughts that went

through the minds of the uninstructed subjects were also varied. Each girl, however, thought about aim. Some girls thought about the way to hold the arrow on the hand, the method of standing, or the distance to pull the string of the bow.

After their initial trials at shooting, the experimental group members concentrated on the individual instructions which the instructor gave them. These corrections and ideas about aim are mentioned in all the accounts that they wrote of their thoughts. By the end of the fourth period, the group had approximated the form being taught to them.

The members of the non-tuition group, after their initial trials at shooting, were concerned with the methods of shooting. They tried out various ideas of their own. They watched other members of the group and copied their techniques. These students adopted a method of shooting which was found to be partially successful during these early trials. With few exceptions, the method each girl worked out was kept by her throughout the whole experimental period.

One difference noticed between the two groups was that the students in the tuition group thought about the form which they had been taught, but did little experimenting with ideas of their own. Students in the other group were mostly concerned about aim, but tried

out ideas regarding technique whenever they thought they had to in order to improve their scores.

The members of the tuition group generally went through four stages of learning. In the first and third stages, they concentrated on their technique and on improving it. In the second and fourth stages they paid little attention to technique, but concentrated on aim.

Students in the non-tuition group did not go through these same stages. These students started thinking about aim. They then thought of technique only when they had to in order to hit the target with their arrows. At the end of the experimental period, most of these students were still thinking about aim and form alternately.

The students in the tuition group said that they learned very little from watching others in their group shoot. The members of the non-tuition group said that they did learn from watching their classmates shoot, and from copying their technique. However, observation of differences in form indicated that this group did not gain materially by observing and imitating the behavior of other archers.

The immediate effect of tuition upon members of the group was to hinder their performance. The students in this group said that individual correction helped them more than did any other type of instruction, even though

it tended to lower their score at the time it was being given. The members of the non-tuition group said they wanted instruction in aiming, individual correction of faults, and demonstration of technique.

The members of both groups attributed losses in score to many reasons. Among these were: lack of attention and effort, tenseness, nervousness, hurry, physical illness, and mental depression. The instructed subjects also listed attention to a particular part of the shooting technique as a major cause of loss in score. The uninstructed subjects, as has been noted, paid little attention to details of form.

Interpretation.- The tuition group showed rapid growth in performance, but was almost entirely dependent upon the instructor for this advancement in achievement. The non-tuition group members were slower to advance in performance, but their advancement was quite independent of the instructor.

The members of the tuition group were flexible and willing to change their technique of shooting as the experimental period went on. The members of the non-tuition group were inflexible; they acquired a usable technique and kept it throughout the experiment.

The members of the tuition group found it easy to concentrate piecemeal upon the technique of archery.

They worked on each part of the technique and then fitted the parts into the whole. The non-tuition group members did not find it easy to concentrate on the parts of the skill. Neither did these students realize the necessity for perfecting the parts of the technique in order to raise their scores.

CHAPTER VII

SUMMARY AND INTERPRETATION

The Problem and Procedure

The Problem.- The major purpose of this investigation was to study tuition as a condition affecting learning. The investigation was restricted to an analysis of the process of learning the complex motor skill of archery by two groups of women college students under conditions comparable except for the experimental variable of tuition. The members of one group were given regular and systematic instruction in the technique of archery of the type commonly presented by teachers of this sport. The members of the second group practiced archery under the observation of the experimenter, but without instruction. The general purpose of this investigation was to determine the effects which tuition during practice had on the process of learning the complex motor skill of archery. This investigation was undertaken to discover whether students aided by tuition and other students practicing without this aid learned in a similar manner.

Specific Questions.- Four major questions were raised at the beginning of the investigation, as follows:

1. What is the effect of tuition in archery upon those aspects of learning represented in curves of learning?
2. How are the factors of intelligence, size, experience in physical education, and personality related to achievement in archery, for the two groups compared?
3. How are fluctuations in the learning curves of individuals and groups learning archery related to the presence or absence of tuition?
4. What light upon the process of learning archery in the presence or absence of tuition is shed by the introspective reports of subjects and by non-quantitative records of behavior kept by the experimenter and other trained observers?

Implications of the Study.- There have been relatively few systematic attempts to determine and describe the process involved in learning aided by tuition. Most of the studies that have been made have been carried out under laboratory conditions rather than typical classroom surroundings. In the laboratory studies of the effects of practice on learning a skill, experimenters have almost invariably set up rigid conditions for presentation of the learning problem and for stimulation of the subjects, and then left the subjects to their own devices. Teachers of skill do nothing of this sort. Instead, they demonstrate, analyze, and describe the correct process while

drilling the students in methods of work which prevent errors. Teachers of motor skill need to know more about the effects of their teaching in order to be able better to direct their students.

The Subjects.- Two classes in archery were formed, with twenty subjects in each. The members of each class were girls studying at Southern Illinois Normal University in Carbondale, Illinois. All of the subjects had selected archery from among a group of sports that grant credit toward graduation.

Matching of Groups.- No attempt was made to match the individuals in the two groups with each other. The groups were highly similar, however, in terms of certain variables. These were height, weight, mental ability, and previous physical education experience. The two groups were considered at the start of the experiment to be equally able to acquire skill in archery.

Physical Setting.- The experiment was carried on in a gymnasium where the two archery groups were relatively free from the effects of wind and weather. The subjects had no practice away from the gymnasium, and had no opportunity to see other archers shoot.

Experimental Variable.- The members of the two groups learned archery under radically different conditions. One class, the tuition group, was taught an accepted technique of shooting a bow and arrow; the other

class, the non-tuition group, learned without instruction other than the minimum amount necessary for the manipulation of the equipment with safety. Each group met each Tuesday and Thursday for fifty minutes during March, April, and May, 1943. The experimental period included eighteen practice periods during which arrows were shot and scores recorded.

Records.- Records were kept of the proceedings in each class, the instruction given to the tuition group, and the daily scores for each individual and for both groups.

Each individual taking part in the experiment took a personality test. Interviews were held with each student during the time of the experiment. The subjects wrote accounts of their thoughts while they were shooting. The members of each group also wrote answers to certain set questions that were asked during the process of the experiment.

Effect of Tuition upon the Aspects of Learning Represented in Curves of Learning

General Contour of the Learning Curves for the Two Groups.- The characteristics commonly found in learning curves for motor skills appear in the curves plotted for each group: rapid initial progress, a negatively ac-

celerated curve revealing a gradual slowing down of the rate of gain, irregularities more or less related to general conditions of work and motivation, and occasional appearances of plateaus or periods of slow progress.

The process of learning a motor skill conforms to this pattern whether or not the learner is aided by tuition. Instruction is not able to overcome the daily fluctuations which are inherent in curves drawn from data obtained from students learning a motor skill by their own efforts.

Irregularities in Individual Scores.- The individual learning curves for each member of both groups were plotted. All the curves vary one from the other. No two are alike. Marked irregularities are seen in all the individual records.

The irregularities in each individual curve were counted and added to the corresponding total for each other member of the group. The number of irregularities occurring among the tuition group members was approximately the same as the number occurring among the non-tuition group members. Instruction in archery was unable to smooth out the irregularities in the learning curves.

Effect of Tuition upon Rate of Learning and Level of Achievement.- The instructed subjects started at a higher level of performance than did the uninstructed ones,

and maintained superiority throughout the time of this study. The tuition group progressed at a faster rate than did the non-tuition group both during the initial and latter stages of learning.

Since the purpose of any instruction is to aid the learners to acquire skill and progress as fast as possible, it was expected at the outset of the experiment that the tuition group would achieve more than the non-tuition group during the limited time of this study. The data collected corroborate the belief that a skilled teacher can aid students to perform a motor skill during initial trials with much more success than the students could achieve by their own efforts. By instruction, the teacher can assist the student to learn faster than he would without tuition.

Relationship between Physical and Personality Factors and Achievement

Relationship between Intelligence Test Scores and Achievement.- There was a slight relationship between the mental ability test scores and the achievement of students being given systematic instruction in archery. The brighter students in this group tended to profit more by instruction than did the duller students.

The mental ability of the uninstructed students had little influence upon their achievement. The brighter students failed to use their ability to determine ways of

improving their score. Instead, like the duller ones of the same group, they hit upon and continued to use a method of shooting that gave some initial success.

Relationships of Height, Weight, and Physical Education Experience to Achievement.- Height, weight, and previous physical education experience gave some advantage to certain members of the non-tuition group. The advantage gained was retained in some degree throughout the process of learning the skill.

Tuition, when it is provided, has more influence on success than have the above-mentioned factors, and operates to nullify any advantage accruing from size, strength, or earlier experience.

Relationships between Measured Personality Traits and Achievement.- Correlations were computed between achievement in archery and three traits of personality as measured by a personality test given to all subjects. The traits measured were those of sociability, neurotic tendency, and self-sufficiency.

In general, the correlations found tended to be small and insignificant in size, in view of their probable errors. For the uninstructed subjects, there was practically no relationship between any of the personality traits and achievement in archery.

For the subjects given tuition in archery, there was practically no relationship between achievement and

sociability, or achievement and neurotic tendency. Some relationship seemed to exist between the self-sufficiency of the students in the tuition group and their achievement in archery. The students who tended to ignore the advice of others had poorer scores, on the whole, than did the students who sought advice and encouragement from others. Students who profited most by instruction were those who did not try to depend on their unaided efforts, but sought advice from others.

Analysis of Fluctuations in the Learning Curves of the Two Groups

Direction of Changes in Score within Single Practice Periods.- Within any single practice period there was a general tendency for scores to rise. This was true for the scores of the subjects in both groups. In spite of the general upward trend in score, the individual students varied greatly during practice periods. Their scores in successive trials rose or fell, or first rose and then fell, or fell and then rose, or remained the same. Tuition had no noticeable effect upon lessening or controlling these fluctuations within practice periods.

Direction of Changes in Score between Practice Periods.- Most of the subjects in both groups tended to have a decrease in score from the time of the last arrows

shot at one practice period to the first arrows shot at the next practice period. However, there was also inconsistency in this. None of the students invariably lost during the interval between practice periods.

Change Occurring in Achievement Following a Week's Cessation from Practice.- During the school's spring vacation period, the students missed two regular practice periods. This longer than usual interval between practice periods seemed to have a deleterious effect upon the instructed subjects, whose group score dropped at that time. While such an extended period without practice probably had a similar effect upon the uninstructed students, it was not quite so apparent. The non-tuition group had already suffered a loss in score previous to the prolonged period without practice. Following the holiday, its average score remained at the lowered level.

Changes in Achievement under Stimulation of Competition.- Tournaments were held during this experiment in order to motivate practice. This competition seemed to act as an incentive for the instructed subjects, whose scores rose on all but the last tournament day. Competition did not seem to be equally effective for the uninstructed group. It is probable that the students who had the assurance of correct form from the instructor could apply to good effect during competition the technique which they had

mechanized. The students who were depending entirely upon their own efforts to learn the skill probably lacked assurance. This would tend to keep them from knowing and perfecting each detail of the technique, and then mechanizing it. As soon as these students were placed under a somewhat greater strain due to competition, their imperfectly organized skill broke down.

Rank at Various Stages.- There was some tendency to relationship between achievement at each practice period and general achievement. The best indication of rank in total achievement is from rank at the mid-point of the experimental period; the poorest from rank at the beginning. The relations are in general stronger for the group that had no tuition, a fact probably related to the tendency to keep their relative status from the beginning to the end of the experiment. The subjects who had no tuition hit upon a pattern of behavior that brought about some success. Knowing no better and having no one to tell them a better way, they tended to retain their methods of work and hence their relative status.

Analysis of the Process of Learning as Shown by Introspective Accounts and Non-quantitative Records of Behavior

Sources of Material.- The students of the two groups wrote introspective accounts of the thoughts and

ideas that went through their minds while they were shooting. They also wrote answers to set questions which were asked them. During the experiment, an observer was present in each class to record class proceedings as well as conversations between students about archery. Following each class period, the instructor wrote an account of what went on during the class, and also recorded interesting happenings. During the last few weeks of the study, each student was interviewed. During these interviews, the students were asked about their reactions to archery, and about their learning process. A compilation was made of data from all these sources.

Thoughts of the Tuition Group during Successive Practice Periods.- During the first practice period, the students in the tuition group thought about the aspects of form that had been taught and with which they were having trouble. They also considered many matters extraneous to archery; but they did little in the way of experimental problem solving.

During the second practice period, a few of the students in this group recalled that no ideas at all went through their minds as they were shooting some of their arrows. Most of the students, at some time during the practice period, recalled the individual instruction the teacher had given them. The recollection of this instruction and a concern about aim were common to all

students.

During the third and fourth practice periods, the introspective accounts of the tuition group continued to show variety. However, each individual tended to repeat the same ideas; but these were different from those of the other members of the group. The members of this group, more and more, reported many periods during which their minds seemed to be blank while they were shooting.

Throughout the entire experiment, the tuition group members wanted to have their faults corrected. Following this correction, they were able to work on the skill piecemeal without falling into other errors. However, concentration upon a part of the technique, as well as concentration upon correcting an error, hindered the performance of most of the students. This group found that individual instruction was more helpful than group instruction.

Thoughts of the Non-tuition Group during Successive Practice Periods.- The members of the non-tuition group, on the first practice day, thought mostly about where they should aim to hit the target. They were also concerned about the different techniques with which they were experimenting.

During the second, third, and fourth practice periods, the group members became more concerned with the form of archery than they had been on the first day of

practice.

The non-tuition group members concentrated mostly on aim throughout the entire experiment. They thought only about form when they were not being as successful as they thought they should be, and their concentration upon aim had not helped them. The students did not seem to realize the necessity for perfecting the parts of the technique in order to raise their scores. Therefore, they concentrated on aim, and tried to make this compensate for the deficiency in technique that they failed to recognize.

Discontinuance of Introspective Accounts.- The introspective accounts for both groups were discontinued after the tenth practice period. At that time, the students said that their reports were becoming mere reiterations of what they had previously said.

Techniques of the Learners during Various Practice Periods.- By the fourth practice period, the students in both groups had attained an approximation of their final form in archery. The members of one group had achieved this form in a different way from that of the other group.

The tuition group was much more flexible in acquiring form than was the other group. The tuition group members allowed themselves to be changed by the suggestions of the instructor; and, although this change might bring a temporary loss in score, they were willing

to attempt it. The students asked the instructor the reasons for their misses, and depended upon her suggestions for correcting their errors.

The members of the non-tuition group were much less flexible than the tuition group while they were learning archery. The non-tuition students acquired a fairly successful technique of shooting. They kept this technique and were unwilling to experiment with another form that might improve their scores in time, but that temporarily would cause loss in score. The members of this group concentrated upon their aim rather than upon consistency of form. The advancement of this group was quite independent of the instructor.

Stages in the Course of Learning Archery.- The tuition group seemed to pass through four stages in their learning during the time of the experiment. During the first and third stages, the students broke the skill into its component parts, and worked on each part separately. During the second and fourth stages, the girls worked on the entire skill and on aiming without concentrating on any single phase of the technique.

The students in the non-tuition class apparently did not go through the four stages of learning evinced by the tuition group; or the stages were not so clearly marked as were those in the other group.

Effects of Observation of Other Learners during Practice.- The students being taught archery learned very little from watching their classmates shoot. They noted the form of the other group members, but learned very little from this observation. The members of the non-tuition group thought that they did learn from watching others of their group shoot. They said that they tried to copy certain successful techniques. However, observation of the differences in form used by the members of this group led the writer to believe that the students did not learn much from watching others; or, if they did learn from watching their classmates, they did not make use of that learning by applying their knowledge to their own technique.

Reasons Given by Learners for Their Fluctuations in Performance.- Most of the students gave more than one reason for their losses in score. The members of the tuition group thought that attention to detail and correction of an error caused more drops in score than any other single item. Very few of the students in the non-tuition group listed this as one of the causes for their losses in score.

Members of both groups listed as one of the main reasons for losses in score the feeling of tension coming from trying too hard. Other explanations for score losses given frequently by subjects were: feeling bad physically, being depressed mentally, failing to pay attention, and

lack of effort.

Implications of the Study

Psychological and Educational Implications.-

Following is a brief series of statements, based upon this investigation, that suggest possible broad applications to the psychology and teaching of motor skill.

1. Teachers cannot smooth out the irregularities in learning curves. The forward movement of learning is by its very nature tentative and uncertain. Improvement and loss are intermingled in learning, by the very nature of the process, but with improvement outweighing loss.
2. Teaching a skill negates the advantages which some learners derive from their physique, but takes advantage of the superior capacity for intellectual analysis and insight of brighter learners.
3. Teaching, at least through the period of instruction represented in this study, results in increased flexibility of behavior. Apparently, it takes teaching to prevent the learner from early falling into a set pattern, far below his potentialities, yet bringing some measure of success.
4. In at least three ways, the teacher aids the learner to vary his behavior.
    a. He directs the learner's attention to more adequate techniques than those that the learner

has been employing. He thus stimulates the learner to break up faulty techniques, even at the temporary loss of achievement. In teaching a complex skill, this process is repeated again and again.

b. The teacher promotes the growth of intellectual insight on the part of the learner into the factors related to his success. The instructions given by the teacher make a major contribution to the improvement of the learner's conception of the skill that he is attempting to master.

c. Finally, the teacher's attitudes and encouragement serve to give the learner a feeling of security and confidence in giving up a familiar mode of behavior and seeking one that is better.

Limitations and Applications of the Study.- This study is limited in its specific findings to the single motor skill, archery, taught or learned under the conditions of this investigation. The extent to which results apply to other fields of skill and conditions of learning is, of course, unknown. Further research is needed to determine the broader applications of the findings of this study. In addition to archery, such sports as golf, bowling, riflery, swimming, and various field events, industrial psychology, military psychology, and doubtless many other fields might

profit by research of the type exemplified in this investigation.

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APPENDIX

TERMS USED IN ARCHERY

Glossary of Terminology.- For the convenience of the reader, the following glossary of archery terms has been compiled.

Aim--act of directing the arrow toward the target

Anchor point--point on the chin to which the hand is drawn and where the hand remains each time before the arrow is shot

Armguard--leather strip worn on the inside of the bow arm to protect it from being hit with the string

Backstop--upright made of straw placed behind the target face for the purpose of catching the arrows

Belly--the inner side of the bow

Block--point of aim placed on the floor at which the archers aim their arrows

Brace--act of placing the bow string in the upper groove so that the string is taut and ready for shooting

Cock feather--the odd-colored feather in each arrow which when nocked correctly rests on the side away from the bow

Crest--band of colors painted on each one of a set of arrows to distinguish the set from that belonging to another archer

Draw--act of pulling the string of the bow back to anchor position

End--six arrows shot consecutively by one archer

End score--score made by the shooting of six arrows

Face--colored scoring portion of the target composed of five concentric circles of

different colors. Each color has a specific score value. The bands of color from inside to outside are gold, red, blue, black, and white.

Fingertab or finger guard--a piece of leather worn on the fingers of the drawing hand to protect the fingers from the constant rubbing of the string

Form--technique used for shooting

Grouping of arrows--shooting the arrows so that they hit in approximately the same place

Handle--the wrapped portion at the center of the bow which should be held by the hand of the archer

Hit--any arrow which touches the scoring surface of the target face and remains there, or bounces off, or goes through

Limb--the upper or lower part of the bow from the handle to the tip

Loose--act of letting the string slide off the fingers, causing the arrow to fly

Nock--act of putting the arrow on the bow string; or, the slit in the arrow which fits on the string

Overdraw--act of drawing the arrow past the bow hand, thus making it possible for the arrow to injure the hand

Pads--the tips of the fingers between the first joints and the ends of the fingers

Percentage score--per cent of possible score which could be made with a prescribed number of arrows

Pile--tip or point of the arrow

Point of aim--spot at which the archer aims the arrow in order to hit the target. When the archer draws the string to his chin, he seldom can aim at the target face and hit

it. When the archer shoots from twenty yards distance, he aims at a spot on the ground. This spot is called the point of aim.

Poundage--number of pounds of pull needed to draw the arrow to its full-drawn position

Practice group--seven girls shooting the arrows at about the same time.

Release--technique used to let the string slide off the fingers

Round--target competition participated in by archers

Score--method of counting in archery. The number of points made by the arrows which hit the face. A hit in the gold scores nine points, one in the red seven points, one in the blue five points, one in the black three points, and one in the white one point. Any arrow which rebounds from the target face or passes completely through it scores five points. An arrow cutting the line between two colors counts the higher score.

Self arrow--an arrow made of a single piece of wood from the nock to the pile (or tip)

Stance--body and foot position of the archer

Technique--the form used for the method of executing the skill of archery

Tournament day--that practice period during which the subjects compete against each other for highest score, highest end score, and greatest number of hits.

Unbrace--act of taking the string from the groove at the top of the bow prior to putting the bow away

RECORD OF PREVIOUS PHYSICAL EDUCATION EXPERIENCE WHICH WAS FILLED IN ON MARCH 11 BY STUDENTS IN BOTH GROUPS

Name_____ Class_____
Height (in inches)_____ Weight_____

Physical defects
Major subject: Minor subject:
What high school did you attend?
Did it have a gymnasium?
What physical education did you have during elementary school?
What physical education did you engage in during high school class periods?
Freshman year--
Sophomore year--
Junior year--
Senior year--
What extra-curricular physical activities did you engage in in high school?
Freshman year--
Sophomore year--
Junior year--
Senior year--
What colleges have you attended?
What physical education classes have you engaged in in college?
Freshman year--
Sophomore year--
Additional--
What extra-curricular activities in physical education have you engaged in during college?
Freshman year--
Sophomore year--
Additional--
Have you watched any one shoot a bow and arrow? If so, where?
Percentile score--
Pound of bow--
Length of arrows--

DESCRIPTION OF THE EXPERIMENT AS EXPLAINED TO THE TWO ARCHERY GROUPS ON MARCH 11, 1943

We are carrying on a psychological experiment in archery this spring. We know very little about the effects which teaching has upon the way in which you go about learning a motor skill. In order to learn more about the effects of teaching upon the individual learners, we are conducting this experiment.

One class, that one meeting during the third hour, is to be the one in which we insist that the students learn a specific method of shooting a bow and arrow. The other class, meeting during the sixth hour, we will let use any method they wish in order to hit the target. We are not comparing the results of one class with the other in order to grade you. We do not care whether the members in one group are better than the members in the other. What we are interested in is discovering just how you go about learning a skill.

For instance, if we insist on a certain form, will the class being compelled to use this form learn faster or slower than the class whose members shoot in the manner they wish? We can only do this with your complete cooperation. I will want you to tell me how you are learning--that is a hard job. For example, do you do just as I say, or do you try and think out reasons and ways of shooting? Try as you go along to try to figure out how you are learning: what it is that makes you do this and that. Try to remember what you think about in class, and write it down later. Try to look inside of your minds, see what is happening, and then write it down.

Please do not talk about archery to the members in the other class, or to other people who already can shoot a bow and arrow. If, however, you should learn something from another person, please tell me that you have done so. Then I will know how you learned that idea. If you copy the form of somebody else in your own class, tell me. This will not affect your grade, but it will help me to discover how you are learning.

Please do not be absent from this class. This is not a strenuous sport, and you can participate in it when you are not feeling too well. You come to class, but tell me if you feel sick. That may affect your shooting, so I will want to know about it. If you can come to school, come to class. If you are too ill to come to school, re-

port to me when you return, and you may make-up the absence before the next meeting of the class. If you are absent on Tuesday, come to me on Wednesday and make up the period. If you are absent on Thursday come to me on Friday and make up the absence.

I want you to enjoy this class in archery, and we will do everything possible to help you to enjoy it.

You will compete against others in your own class, not against the members of the other class. I will bring a chart of your progress to the class in order that you can compare your scores.

QUESTIONS ASKED OF EACH STUDENT IN THE ARCHERY CLASSES DURING INTERVIEWS

Name_____

Week of class_____

First date of interview_____

1. Are there days when you think you can shoot better than others?
2. Are these "hunches" reliable?
3. Do you have classes before this class?
4. What effect does work in these classes have on your shooting?
5. Do you have classes immediately following this?
6. What effect do these classes have on archery?
7. Do you feel more like shooting on Tuesday than Thursday?
8. Do you do better on Tuesday than Thursday?
9. Do you think about your form in the act of shooting, or just between shots?
10. Did you think about your form during shooting at first?
11. Does thinking about form while shooting help or hinder you?
12. Does thinking about form between shots help you?
13. Do you think about the special instruction I am giving you that day, or on another known fault?
14. Do you do better or worse when you think about a special part of form such as release?
15. At the time I am correcting you, does this hinder you?
16. Do you do better or worse after I have corrected you and go away?
17. Is this because I have gone, or because you have learned something?
18. Do you analyze your misses?
19. What type of analyses do you do?
20. Do you think of original causes of errors or only of things I have pointed out?
21. Do you ask me, or a classmate, or try to figure out your own errors?
22. Are you experimenting with anything other than aim?
23. What particular part of form do you think about?
    1.
    2.
    3.
    4.
24. Did you at first think of all parts of form, and later think of parts?
25. Did you at first think of each separate part?

26. Do you think less about form now than before?
27. Why?
28. How are you learning? From being told?
29. Do you analyze every shot you make?
30. Which shots do you analyze?
31. Does your analysis do any good?
32. If you are shooting well, do you stop thinking?
33. Do you do your best shooting when you do not think?
34. Did you have more enthusiasm at first than now?
35. Why?
36. Is shooting easier or harder now?
37. Why?
38. Why did you improve faster at first?
39. When you are shooting well, do you continue to shoot well?
40. Why?
41. Why do you slip back and do poorer some days?
    1. Lack of attention and effort
    2. Try too hard
    3. Tension
    4. Physical feeling
    5. Mental feeling
    6. Noise, temperature
    7. Degree of difficulty of the skill
    8. Attention to detail
    9. Forget to think
    10. Lack of motivation
    11. Lack of interest
    12. Chance
42. Why do you have plateaus?
    1. Hard to eliminate error
    2. Old habits
    3. Perfect one part before go to another
    4. Break down stages when learn new
    5. Limit of usefulness of one method
    6. Lack motivation
    7. Lack of effort

QUESTIONS GIVEN TO THE STUDENTS IN BOTH GROUPS TO ANSWER ON MARCH 25, 1943

1. Are you enjoying archery?
2. Are you discouraged?
3. Do you feel tense or relaxed when you shoot?
4. Can you keep your mind on the skill, or do you think of other things?
5. Do you understand aiming?
6. Are you working on any special phase of the skill? If so, what?
7. Are you trying different techniques and ideas of your own?
8. Do you learn anything from watching the others in the class?
9. To what do you attribute your success or failure to hit the target?
10. Do you try to analyze your errors?
11. Do you try to figure out why you miss the target?
12. Do you try to figure out why you hit the target?
13. What effect does hitting the target have on the next shot?
14. What effect does missing the target have on the next shot?
15. Can you "feel" when you are doing the right thing?
16. What method of instruction helps you most?
    1. Demonstration
    2. Explanation
    3. Correction of individual faults
    4. Combination of which of these?
17. What type of instruction would you like that you do not get?
18. What are your difficulties?

QUESTIONS GIVEN TO THE STUDENTS IN BOTH ARCHERY CLASSES TO ANSWER ON APRIL 8, 1943

1. What effect does hitting the wall with an arrow have upon you?
2. Which of the following are you experimenting with and try out on your own method?
   _____ 1. Aim
   _____ 2. How far to pull the string
   _____ 3. How to release
   _____ 4. Any other? If so, what?
3. Does your correction of one of your faults make you commit another fault?
4. On which of the following are you concentrating?
   _____ 1. Whole act of shooting.
   _____ 2. A part or phase of shooting.
5. Are you conscious of being fatigued while you shoot?
6. Are you tired when you finish the period of shooting?
7. Do you feel frustrated when you shoot?
8. Do you think about archery outside of class? If so, what do you think?
9. Do you talk about archery outside of class?
   1. To whom do you talk?
   2. What do you talk about?

OBSERVER'S NOTES TAKEN IN THE TUITION CLASS ON MARCH 23, 1943

Instructions

Do not close the right eye. The pile of the arrow points to the point of aim, then if the arrow does not go where you want it to, shift the point of aim accordingly.

Worked on the Following Points

Keep body straight, and do not lean away from the target.
Keep the pile of the arrow pointing toward the block.
Keep the left arm turned out.
Keep the hand underneath the chin when anchoring it.
Watch the position of your feet, keep the feet parallel.
Keep the right elbow high.
Aim lower or higher than the block on the floor if the arrow is going above or below the target.

Instructions

Weight must not be on the right foot. It should be kept evenly distributed on both feet. If this is very difficult for you, put the weight of the body forward onto the left foot.
The feet should be parallel, with the left hip toward the target.
The taller and the shorter girls will probably have to move their blocks, do not hesitate to do so. The blocks have been put down as a guide, they will not be accurate for each of you.
Place the arrows in front of you, and then reach to pick them up without moving your feet.
While you are waiting for the girls to retrieve their arrows, practice pulling the bow without an arrow in it.

Worked on the Following Points

Relaxing the left shoulder to avoid hunching it.
More stress on keeping the right elbow high.
Keep the nose in contact with the string while sighting.

Individual Correction

Heatherly should straighten her left arm more, it is quite bent.

Thompson is jerking her left arm and collapsing at the end of the release. Hold the position until the arrow touches the target or backstop.

Souther is bending her head to the side. Straighten your head and bring the string to it.

Calvin should watch the cock feather and see that it is away from the bow as she shoots.

Instructions

If the arrow slides off the left hand, you may be pinching it too hard, or you may be placing the thumb on the arrow. Try just lightly touching the arrow with the fingers, and pull to the chin, not out to the side.

Individual Corrections

Heatherly is sighting down the arrow. Draw the string under the chin and keep the head upright as you look at the pile of the arrow.

Wright is throwing her left arm. Hold steady and keep your feet parallel and straddling the line.

Huey should aim with her right instead of her left eye.

Calvin should try to open her fingers as she releases without throwing her hand away from her face.

Instructions

If anyone changes her bow next time, please tell me.

Next time, each girl should get her own block and put it down so she can change it as she needs to.

Keep that right hand underneath the chin.

Do not let the right hand fly off the face as you release.

OBSERVER'S NOTES TAKEN IN THE NON-TUITION CLASS ON APRIL 15, 1943

Homberg seems to be shaking more than ever. Her whole body shakes. She is using her thumb and index finger to draw the arrow back.

Rodeck is pulling back farther. She sights with her right eye now.

T. Mitchell now pulls all the way back. She has good aim. She sights with both eyes. Her form and shooting are better today.

Holmes lifts her head up when she shoots and stands on both feet until she releases; and then she rises on the toes of her left foot and thrusts her body forward. She has her right elbow much higher than her right wrist.

Spriggs still holds her right arm close to her body. She sights with both eyes and has to look down to do so because of the position of her arrow. Miss Davies warns her to keep her left elbow turned out of the way of the string.

Freeburg stands with her weight on the toes of her right foot. She pulls all the way back to her cheek, and hits well.

Garrison has a poor release and drops her arrow out of her bow just as she starts to shoot. She pulls the string out of the nock of the arrow before she releases the string. As she releases, she lets her hand follow the string, and shoots low. She sights with her right eye.

Laffoon sights as she draws the bow up. She sights with her right eye.

Davis shifts her feet every time she picks an arrow off the floor. She draws the arrow only part of the way back.

The instructor tells the class,"If you have one arrow that is consistently going off the target, report the arrow to me and get a new one. If the same arrow goes astray every end, it is likely to be a faulty one."

Jackson does not seem to pay much attention to where she aims. She lets go of the arrow before the bow string is even half way pulled back. Her arrows hit right above the floor, way below the target face. She sights with both eyes. She jerks her bow arm as she releases.

Tisdale sights with her left eye. She shoots with her body turned facing the target.

Chaney sights with her right eye, but does not pull the arrow all the way back.

Wagner sights with her right eye. She does not pull the arrow all the way back. She tends to hit low. Someone asks her what she does wrong, and in answer she says,"I do not pull all the way back, I shut my eyes and a few other things."

Dennis sights with her right eye. She has raised her right elbow so it is now as high as her right hand. Her release is jerky.

Williams sights with her left eye.

Rodeck is not pulling back as far as she used to.

Konya pulls about half way back. She sights with both eyes open.

Baldwin pulls the arrow all the way back to her cheek, and sights with her right eye as though she were sighting a gun.

Smith also uses her right eye when sighting.

Smith aims to the right, at least one foot to the right and below the target. She says,"I aim at the target and the arrow goes to the left and high."

Homberg says, "For one end I tried to use the techniques that some of the other girls use. One end I tried to shoot with my right elbow as high as my wrist, and I missed the target all but one time. In the next end, I held my hand at the top of the handle instead of down at the bottom of the handle. My arrows all went high. But the winding was too high for the arrow, so the arrow was not nocked right."

Russell almost overdraws. Once she pulled the arrow off her bow hand.

SAMPLE SCORE CARD ON WHICH EACH SUBJECT RECORDED HER SCORE FOR EACH PRACTICE PERIOD

NAME _____

DATE _____

End	Score						Hits	Score for End
1								
2								
3								
4								
5								
6								
	TOTAL							