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Volley Ball Skill Tests for Eighth Grade Boys

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VOLLEY BALL SKILL TESTS

for

EIGHTH GRADE BOYS

by

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VOLLEY BALL SKILL TESTS
FOR
EIGHTH GRADE BOYS

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by

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This thesis, offered by Warren W. Freed, as a partial fulfillment of the requirements for the Degree of Master of Science in Education in the University of North Dakota, is hereby approved by the Committee under whom the work has been done.

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Table of Contents

CHAPTER I

INTRODUCTION

American pioneers in physical education were intensely interested in measurement. Edward Hitchcock at Amherst, starting in 1861, and Dr. Dudley A. Sargent at Harvard, in 1880, were pioneers in the use of anthropometric measurements. Sargent was also instrumental in developing strength tests which shifted the emphasis from body symmetry and size to strength. The Intercollegiate Strength Test which he proposed has been slightly revised by C. H. McCloy[1] and F. R. Rogers and is being used extensively in the modern program of physical education.

Increased knowledge of the heart and circulatory system shifted the emphasis from strength testing to cardiac funtional tests. These tests were not very popular with physical educators of that period because of their complexity and lack of practical application.

The early years of the present century found tests of athletic ability gaining favor. Tests of this type took the form of track and field events,[2] and have continued to grow in popularity.

The early programs were carried on mainly in colleges and universities. The first well organized attempts to test public school children were made in Cleveland and New York in 1908. In 1913 the Playground and Recreation Association of America published the Athletic Badge Test for boys. This marked the first concerted effort at testing physical

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1. C. H. McCloy, Tests and Measurements in Health and Physical Education, pp. 19-37
2. Ibid., pp. 103-121

ability of public school children on a nation wide scale.[3]

During the last two decades scientifically constructed tests have emerged in the physical education field. Previous to this time tests were established on an empirical bases — the results of what experienced educators in the field believed to be subjectively correct.[4] Increased interest in testing by physical educators has been influenced by the following factors:[5]

1. the increased knowledge of statistics by physical educators.
2. publication of the Research Quarterly.
3. the creation of the Administrative Measurements Section of the American Association of Health, Physical Education and Recreation.
4. increased graduate study in the physical education field.
5. progress in defining the purposes of physical education.

The main objective of testing is to determine the level of ability, achievement, understanding, or appreciation.[6] This objective may be achieved by informal means such as observation by the teacher and the results of competitions within the class. However, if a teacher has a large class it takes a great deal of time before he is able to accurately rate the class from observation.

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3. Edward F. Voltmer and Arthur A. Esslinger, The Organization and Administration of Physical Education, p. 423
4. H. Harrison Clarke, The Application of Measurement to Health and Physical Education, p. 5
5. Jackson R. Sharman, The Teaching of Physical Education, p. 224
6. Ibid., p. 225

There are a number of criticisms of testing. A large number of physical education teachers believe that testing is a waste of time and effort. Testing interferes with the successful execution of a well planned program. Conditions for administrating tests are unlike actual game situations. The suspense and dread of failure is a serious emotional problem.

Along with the criticisms of testing there are also a number of values. Some of the values of a testing program are as follows:

1. guides teachers in evaluating the success of their work.
2. helps pupils to see what progress they have made.
3. helps diagnose difficulties of pupils.
4. provides evidence concerning curriculum revision and time allotment.

A list of objectives for pupil development through physical education usually includes something like the following: health or physical fitness, motor skill, knowledge or information, and social adjustment. If such concepts are definite enough to be set up as teaching goals, then the results must be recognizable and a more or less precise means of evaluation must be possible.[7]

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7. M. Gladys Scott and Esther French, Better Teaching Through testing, p. 1

Problem

The purpose of this study is to determine the validity and reliability of a number of volley ball skill tests which might be used to measure the volley ball ability of eighth grade boys. Skill tests have been used for a considerable length of time, but many of the tests have had no statistical work done on them.

According to Clark,[8] "it is through the development of skills and subsequent practice in them that physical educators realize their objectives. Without sufficient skill for satisfactory participation in physical activities, the physical benefits from vigorous strength and endurance activities, the social values from group activities and team sports, the personal-social competence from skill in any socially accepted activity, the recreational competence from activities of value for leisure time, and the appreciation of skilled performance wherever observed are not realized. In fact, skill in physical activities is essential for the well integrated personality. To evaluate status and progress in the acquisition of skills, therefore is an important phase of measurement in physical education."

Purposes

Through the skills tests to be given it is hoped to accomplish the major purposes as follows:

1. to develop tests which can be administered with an economy of time.

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8. H. Harrison Clark, op. cit., p. 261

2. to determine the objectivity and reliability of the tests.
3. to use as few materials as possible.
4. to determine the validity of the tests.
5. to determine how many and which tests are necessary to present a true picture of the boys' playing ability.

Delimitation

This study is confined to eighth grade boys. The boys used in this test are from one junior high school in Fargo, North Dakota. All of the boys are thirteen years of age, and with a few exceptions are of Scandinavian descent.

In determining the results of this test it is necessary to take into consideration the gymnasium in which the tests were given. This gymnasium has a low ceiling which interfered particularly with the serve and passing test.

Tests were administered after the boys had completed a five-week unit in volley ball in which they received instruction in the various volley ball skills two hours per week. Along with their skill instruction the boys played volley ball after school three nights a week in the intramural program.

Eight feet is the height of a regulation volley ball net. This height is generally thought to be too high for eighth grade students. The net height used was seven and one-half feet.

Method of Procedure

Experimental group research was the method used to conduct this study. The first step was to determine the fundamental volley ball skills to be tested.

Step two was to choose tests that would measure these various fundamental skills. Some tests were devised, others were chosen from those already established.

Choosing the subjects to be used in the research was the third step. The number of subjects to be used was determined also.

Administering the tests was the fourth step. Each boy was tested during his class period.

Next, the boys were rated according to playing ability. Expert opinion was used as the method of rating. Ratings were conducted after the regular school hours from four to six p. m.

Results of the tests then were correlated with the criteria and each other. The Pearson product-moment method[9] was used.

Step seven consisted of determining the best possible combination of tests. This was done by multiple correlation using the Wherry-Doolittle Test Selection Method.[10] Following this the results were analyzed.

Conclusions then were drawn from the results.

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9. Henry E. Garrett, Statistics in Psychology and Education, pp. 282-288

10. Henry E. Garrett, op. cit., pp. 435-448

Source of Data

A battery of six tests was given to fifty boys in the eighth grade. All boys were 13 years of age and members of the regular physical education classes of the Agassiz Junior High School in Fargo, North Dakota. Subjects were selected by placing the names of all the eighth grade boys in a hat and drawing fifty. Tests were then administered by the physical education instructor. Fundamental volley ball skills tested are as follows:

(1) Serve
(2) Volley
(3) Spike
(4) Net Recovery
(5) Set Up
(6) Pass

Each subject was rated by a board of experts as to his ability to play volley ball. This board consisted of the following: the instructor; R. D. Brown, principal; and V. J. Dodge, science instructor. All members of the board are well qualified to judge volley ball ability because of a number of years experience in playing and teaching the game. This rating served as a criteria in determining the validity of the tests as a measure of volley ball playing ability.

CHAPTER II

TESTS AND TEST ADMINISTRATION

The purpose of this chapter is to give the reader a clear picture of the tests used in the research so that in analyzing the results of the research he is better able to interpret them. Tests described in this study were chosen after reading books and periodicals concerning the subject, and discussions with other physical education teachers.

Serve Test

In searching through books and periodicals four serve tests were found. These were by Edgren and Robinson,[1] French and Cooper,[2] Reynolds,[3] and LaVega.[4] The test devised by French and Cooper was only one in which statistical procedures have been used to determine the validity and reliability.

Using forty-seven senior high school girls as subjects, French and Cooper obtained the following results:

1. Reliability: r= .68 by the odd-even method, stepped up to .81 by the Spearman-Brown formula.
2. Validity: r= . 63 when correlated with a criterion of subjective ratings, made by four experienced teachers of volley ball.

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1. H. H. Edgren and G. G. Robinson, Individual Skill Tests in Physical Activities, p. 14
2. M. Gladys Scott and Esther French, op. cit., pp. 103-104
3. Herbert J. Reynolds, "Volley Ball Tests," Journal of Health and Physical Education, 1,3:42. March, 1930
4. Robert E. LaVega, Volley Ball, pp. 37-39

Bassett, Glassow, and Locke[5] using college women as subjects obtained the following results:

1. Reliability: r = .84
2. Validity: r = .79

Russell and Lange[6] using girls in Grades 7, 8, and 9 as subjects obtained about the same results as did French and Cooper.

It was decided to use the test devised by French and Cooper as the others were thought to be too difficult for boys of Junior high school age.

A description of the French and Cooper test is as follows:

A. Equipment.

1. Regulation court and tightly strung net, 7½ feet high. Four well inflated balls.
2. Markings
   (a) A line across the court five feet inside and parallel to the end line.
   (b) A line across the court parallel to the net and 12½ feet from the center line which is directly under the net.

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5. Gladys Bassett, Ruth Glassow, and Mabel Locke, "Studies in Testing Volley Ball Skills," Research Quarterly, December, 1940, Vol. XI, No. 4, p. 33

6. Naomi Russell and Elizabeth Lange, "Achievement Tests in Volley Ball for High School Girls," Research Quarterly, December 1940, Vol. XI, No. 4, p. 33

(c) Two lines each five feet inside the court and parallel to the sidelines, extending from the line under the net to the five-foot line described in (a).

(d) The score values of each area were marked on the floor as indicated in the diagram.

B. Test:

1. The player being tested stands in the proper serving area on the court opposite the target and is given twenty trials to serve the ball into the target in the court across the net. Any legal serve is permitted. Foot faults shall count as trials; "let" serves shall be reserved and do not count as trials. The scorer stands on a chair near one sideline about fifteen feet from the net.

C. Scoring:

1. The score values are indicated on the diagram. A ball landing on a line separating the two spaces scores the higher value. A ball landing on an outside boundary line scores the value of the area the line bounds. Trials in which foot faults occur score zero. Twenty trials should be allowed. The final score is the combined score of the subjects twenty attempts.

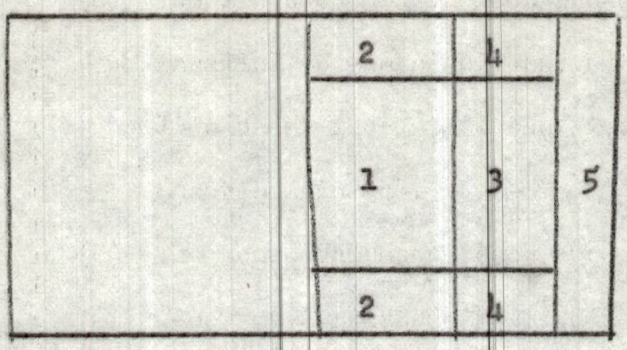

Fig. 1. Floor marking for volley ball serve test.

1 to 5 = scores for respective areas.

Set-up Test

French and Cooper,[7] Edgren and Robinson,[8] and LaVega[9] have devised set-up tests. The test devised by French and Cooper could not be used because it allowed the subject to receive the ball and set it up to herself which is not permissible under boy's rules. LaVega's test was finally decided upon with a few modifications as it was too difficult in its unchanged form.

The test finally used is as follows:

A. Equipment:

1. 4 well inflated balls.

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7. Esther L. French and Bernice I. Cooper, "Achievement Tests in Volley Ball for High School Girls, "Research Quarterly, May 1937, Vol. VIII, No. 2, p. 150
8. H. H. Edtren and G. G. Robinson, op. cit., p. 20
9. Robert E. LaVega, op. cit., pp. 22-25

2. Trough, old tin pipe. Diameter, ten inches; length, five feet; pitch, eight to ten inches in five feet. It is mounted on a scaffold with a height of thirteen feet at the point of drop.

3. To the left and nine feet from the trough is placed a square frame five feet by five feet, made of five inch by one inch material. This frame was attached to the wall on one side, and mounted on jumping standards on the other so that it was parallel to the floor.

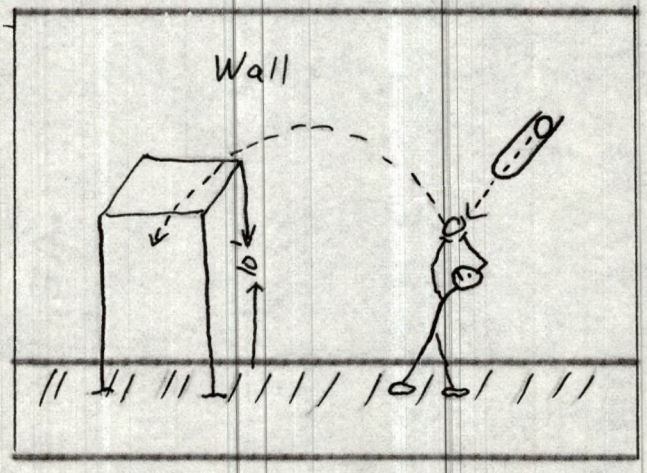

Fig. 2. Setting up the Ball

4. One thirteen foot step ladder.

B. Test.

1. The player being tested stands at a point below the trough where he is best able to receive the ball. The tester stands on the step ladder and places the

ball in the trough. When the player is ready the ball is released without application of force. As the player receives the ball he attempts to set it up in such a manner that it will fall into the goal on its downward flight.

C. Scoring.

1. Into the goal without touching any part of the frame - 10 points.
2. Over the goal and hitting the near side of the frame on the descent - 5 points.
3. Over the goal and hitting the five-foot side between the two jumping standards - 2 points.
4. Hitting the wall, the far side of the frame, and under the goal - 0 points.
5. The final score is the combined score of ten attempts by the player.

Pass Test

It was decided to use the pass test suggested by LaVega[10] with a modification of the scoring area. The scoring as suggested by LaVega seemed to be too difficult for eighth grade boys.

The test used is as follows:

A. Equipment.

1. Tightly strung net seven and one-half feet high, four well inflated balls.

2. Trough, scaffold, and step ladder, the same as used in the set-up test described previously. Distance back from net, twenty-two feet. The front of the trough projects three feet in from the left sideline.
3. Two jumping standards placed on each side line of the court, ten feet distance from the center line. A string is fastened across the court between the two jumping standards at a height of ten feet from the floor.
4. The area between the center line and the string is divided into two equal parts, forming two rectangles ten by fifteen feet.

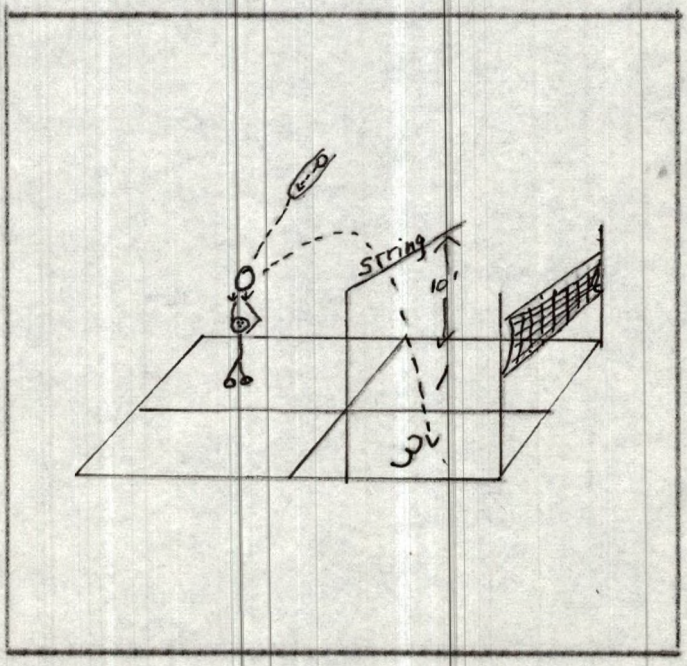

Fig. 3 Pass Test

B. The Test.

1. The tester places the ball in the trough. When the player is ready the ball is released without any application of force. As the player receives the ball he attempts to pass it over the string into the scoring area. Ten trials are allowed.

C. Scoring.

1. Passing over the string and landing in the right forward area - 3 points.
2. Passing over the string and landing in the left forward area - 1 point.
3. Under the string, into the net or out of bounds - 0 points.
4. Balls striking the lines bounding the scoring areas scores the value of the area the line bounds. A ball landing on the line separating the two scoring areas scores the higher value.
5. The final score is the combined score of ten attempts by the player.

Spike Test

The test suggested by LaVega[11] was used as a test of the spiking ability of the players. The test is described as follows:

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11. Robert E. LaVega, op. cit., pp. 50-51

A. Equipment.

1. Tightly strung net seven and one-half feet above the floor.
2. Cord strung above the net thirteen feet from the floor attached to two jumping standards on either side of the court.
3. Markings in scoring area.
   (a) A line across the court fifteen feet from and parallel to the end line.
   (b) Two lines each ten feet inside of the net and parallel to the sidelines, extending from the line under the net to the end lines.
   (c) The areas are numbered as shown in the diagram.

B. The test.

1. The player being tested stands in the center forward area of the court along with the tester. The tester sets the ball up for the spike using the string above the net as a gauge for the height of the set-up. The spiker spikes the ball and attempts to place it in the scoring area. If the player touches the net or extends any part of his body over or under the net the trial does not count. Ten trials are allowed.

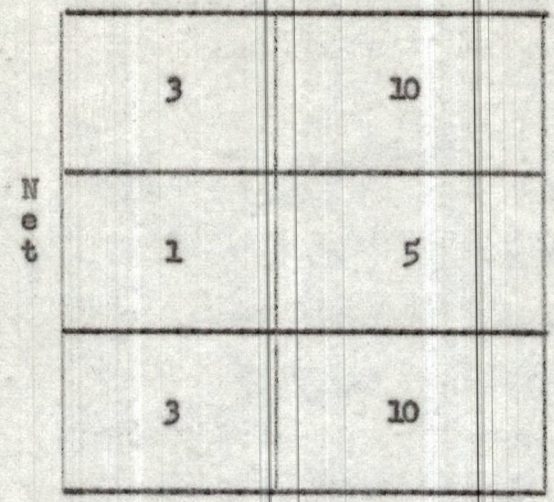

Fig. 4. Spike Test

C. Scoring.

1. Balls landing in the right back or left back area - 10 points.
2. Balls landing center back area - 5 points.
3. Balls landing in right forward or left forward area - 3 points.
4. Balls landing in three area - 1 point
5. A ball landing on a line separating the two spaces - the higher value.
6. A ball landing on an outside boundary line scores the value of the area the line bounds.
7. Trials in which the player touches the net or extends any part of his body over or under the net score zero.
8. The final score is the combined score of ten attempts by the player.

Repeated Volley Test

The repeated volley test was devised by French and Cooper.[12] The test is described as follows:

A. Equipment.

1. Well inflated balls, unobstructed wall space ten feet long and fifteen feet high, and a stop watch.
2. Markings
   (a) A line ten feet long marked on the wall at net height, seven and one half feet from the floor.
   (b) A line on the floor, opposite the wall marking, ten feet long and three feet from the wall.

B. Test

1. The player being tested shall stand behind the three-foot line and toss the ball to the wall with an underhand movement. When it returns, he shall volley it repeatedly against the wall above the net line for fifteen seconds. The ball may be set up as many times as desired or necessary; it may be caught and restarted with a toss as at the beginning. If the ball gets out of control it must be recovered by the subject and brought back to the three-foot line to be started over again as at the beginning. This procedure should be repeated until ten trials have been given, each fifteen seconds in length.

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12. M. Gladys Scott and Esther French, op. cit., pp. 101-103

C. Scoring.

1. The score for one trial shall be the number of times the ball is clearly batted (not tossed) from behind the three-foot line on the floor to the wall above or on the net line. The score for the test shall be the sum of the five best trials out of ten.

D. Reliability.

1. r = .78 correlating by the odd-even method. The subjects were forty-seven senior high school girls.
2. r = .96 computed by the odd-even method. The subjects were seventy-five college women. Ten trials all used.

E. Validity

1. r = .72 when correlated with a criterion of subjective ratings, made by four experienced teachers of volley ball.

Net Recovery Tests

The test used was a combination of tests devised by Reynolds[13] and French and Cooper.[14] The test is described as follows:

A. Equipment.

1. Regulation court, tightly strung net, and well inflated balls.

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13. Herbert J. Reynolds, op. cit., p. 42
14. Esther L. French and Bernice I. Cooper, op. cit., p. 150

2. Place a high hump standard on each sideline back twelve feet from the net. String a cord five feet high between the two high jump standards.

3. Special Court Markings.

   (a) Tie a square target with yarn in the exact center of the net. The diagonal of the square shall be two feet, eight inches. The square shall be so placed that one diagonal is horizontal and the other vertical.

   (b) Two short marks on the floor ten feet from the line under the net; the one, four feet to the left of center, the other four feet to the right of center.

B. The Test.

1. The player may choose whether he wishes to stand on right or left hand side of the target. The instructor will stand on the mark ten feet from the net on the opposite side.

2. The instructor throws the ball into the target with an underarm toss. The player recovers the ball and attempts to bat it back over the string into the rear court. Ten trials are allowed. The player is not allowed to touch the net or step over the center line.

C. Scoring.

1. One point is scored for each recovery that is batted back overhead so it goes over the string and does not touch it.
2. The score for the test shall be the sum of the ten trials.

Criterion Rating

The criterion for the tests was a rating of the playing ability of the players by three qualified judges. Ratings were made after school between four and six p. m. on two consecutive days. The judges observed each player play three games of volley ball. Neither one of the first two judges had observed any of the skill tests or were aware of the results. The boys wore numbered shirts, which aided the instructors to identify them. The judges sat on opposite sides of the court so they were not able to compare ratings. Twenty-five boys were rated each night. Each team played one game, then played its last two games consecutively in order that the judges might gain a better overall picture as to the groups ability.
Names were drawn from a hat in order to see which night the members of the group would play.

In rating the boys, the following five category scale was used.

5 - Superior
4 - Above Average
3 - Average
2 - Below Average
1 - Poor

Before rating the players each judge was given an instruction sheet[15] and scorecard.[16] He was asked to look these over before the ratings started.

In weighting the opinions of the judges the instructors opinion was doubled. This was due to the fact that he had observed the boys in action a greater number of times, and because of this was able to give a truer rating.

The scores of the three judges were totalled. The highest score possible was 20, and the lowest possible was 4.

CHAPTER III

SUMMARY OF TEST RESULTS

Correlation of Tests Used with Criterion

Introduction:

In order to determine the validity of the skill tests, each test is correlated with the criterion. The criterion in this case is the subjects ability to play volley ball as determined by three judges.

The Pearson Product-Moment method is used to find the relationship which exists between the two variables. Reliability of the correlation coefficients is determined by testing them against the Null Hypothesis Theory. When N is 50 and (N - 2) is 48, an r must be .279 to be significant at the .05 level, and .361 to be significant at the .01 level.[1]

Serve Test:

Highest score possible for the serve test is 100. Scores made by the boys ranged from 3 to 63. Scores might have been higher had it not been for the low ceiling. Median score for the test is 27.23.[2] Mean score is 27.2.[3] Standard deviation for the test is 11.75,[4] indicating a large amount of variability.

The standard error of the mean is 1.66.[5] If we are willing to

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1. Henry E. Garrett, Statistics in Psychology and Education, pp. 298-301
2. See Page 4 appendix
3. See page 4 appendix
4. See page 4 appendix
5. See page 4 appendix

take a risk of being wrong once in a hundred trials we can feel confident that the range of true mean lies between 27.2 plus or -2.58 x 1.66 or 27.2 ± 4.28. The range of true mean from the lowest to the highest therefore is from 22.92 to 31.48.

Standard error of the standard deviation is 1.187.[6] It is fairly certain (the probability is .99) that the true standard deviation of the serve test is not larger than 14.93 nor smaller than 8.57 (11.75 ± 2.682 x 1.187).

The correlation between the serve test and criterion is .59.[7] At both the .05 level and the .01 level this r is significant, indicating that the serve test is a good test of ability to play volley ball.

Set-Up Test:

In this test it is possible to obtain a score of 100. Range of score tested is from 2 to 75, with the median score being 34.5.[8] Mean score for the test is 32.3.[9] A large amount of variability is indicated by a standard deviation of 16.80.[10]

Standard error of the mean is 2.37.[11] The probability is .99, that the mean of the set-up test does not diverge from the true mean more than plus or - 6.11(2.58 x 2.37).

Standard error of the standard deviation of the set-up test is 1.7.[12] The probability is .99 that the true standard deviation is not larger than 21.36 nor smaller than 12.24 (16.80 ± 2.682 x 1.70).

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6. See page 5 appendix
7. See page 22 appendix
8. See page 7 appendix
9. See page 7 appendix
10. See page 7 appendix
11. See page 7 appendix
12. See page 8 appendix

A coefficient of correlation .68[13] is found between the set-up test and the criterion. This correlation is significant at both the .05 and .01 levels, indicating considerable relationship between the set-up ability in volley ball as measured by the set-up test and volley ball playing ability as measured by the criterion.

Pass Test:

A perfect score for the pass test is 30. Highest score made by the eighth grade boys is 24 and the lowest score 0. Median score is 5.1,[14] most of the boys were bothered by the low ceiling which no doubt accounts for the low scoring. Mean score for the test is 6.22.[15] The standard deviation is 5.1[16], with the middle 68.26% of the scores falling between 1.12 and 11.32.

Standard error of the mean is .72.[17] The probability is .99, therefore, that the mean of the pass test does not diverge from the true mean by more than plus or - .186($\pm$ 2.58 x .72).

Standard error of the standard deviation is .52.[18] Therefore, (the probability is .99), the true standard deviation is not higher than 6.53 nor lower than 3.77 (5.10 $\pm$ 2.862 x .52).

Correlating the pass test with the criterion, we find r = .53.[19] Because this correlation is significant at both the .05 and .01 levels, it appears that the pass test of volley ball is a good test of volley ball ability.

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13. See page 25 appendix
14. See page 10 appendix
15. See page 10 appendix
16. See page 10 appendix
17. See page 10 appendix
18. See page 11 appendix
19. See page 27 appendix

Spike Test:

Perfect score for the spike test is 100. Range of score for the eighth grade boys was 0 to 90. Median score for the test was 12,[20] with a mean score of 16.42.[21] Many of the boys were too short to score well in this test which no doubt accounts for the preponderance of low scores. Standard deviation for the spike test is 17.22,[22] which indicates a large degree of variability.

The standard error of the mean is 2.43.[23] We may feel confident (probability .99) that the true mean would not diverge from the spike test mean by more than plus or - 6.27 (2.58 x 2.433).

Standard error of the standard deviation is 1.74.[24] The probability is .99, that the true standard deviation is not greater than 21.89 nor smaller than 12.55 (17.22 ± 2.682 x 1.74).

The coefficient of correlation between the spike test and the criterion is .59.[25] This correlation is also highly significant at the .05 and .01 levels. The spike test appears to be a good test of volley ball ability.

Repeated Volley Test:

Range of scores for the boys taking this test is from 38 to 150. Median score for the test is 89.95,[26] with a mean score of 89.3.[27] The standard deviation is 24.3[28] indicating a large degree of

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20. See page 13 appendix
21. See page 13 appendix
22. See page 13 appendix
23. See page 13 appendix
24. See page 14 appendix
25. See page 28 appendix
26. See page 16 appendix
27. See page 16 appendix
28. See page 16 appendix

variability with the middle 68.26% of the scores lying between 65 and 113.6 (89 + or - 24.3).

Standard error of the mean is 3.44.[29] The probability is .99 that the true mean is not greater than 98.18 nor smaller than 80.42 (89.3 ± 2.58 x 3.44).

The standard error of the standard deviation is 2.45.[30] if we are willing to risk a wrong answer one time in one-hundred trials, we may feel confident that the true standard deviation is never greater than 30.87 nor smaller than 17.73 (24.3 ± 2.682 x 2.45).

Correlating the repeated volley test with the criterion produced an r of .85.[31] This r is found to be significant at both the .05 and .01 levels, indicating a considerable relationship between volleying the ball as tested in the repeated volley test, and ability to play volley ball.

Net Recovery Test:

Perfect score for the net recovery test is 10. Scores made by the boys ranged from a low of 0 to a high of 10. Median score for the test is 7,[32] and the mean score is 6.78.[33] The standard deviation is 2.43,[34] with the middle 68.26% of the scores lying between 9.21 and 4.35 (6.78 ± 2.43).

Standard error of the mean is .34.[35] The true mean (probability .99) would be somewhere between 5.90 and 7.66 (6.78 ± 2.58 x 34).

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29. See page 16 appendix
30. See page 17 appendix
31. See page 29 appendix
32. See page 19 appendix
33. See page 19 appendix
34. See page 19 appendix
35. See page 19 appendix

Standard error of the standard deviation is .245.[36] The true standard deviation (probability .99) would never be greater than 3.09 or smaller than 1.77 (2.43 $\pm$ .245 x 2.682).

The coefficient of correlation between the net recovery test and the criterion is .21.[37] This r is not significant at either the .05 or .01 levels, indicating there is little relationship between the net recovery test and ability to play volley ball.

Summary:

With the exception of the net recovery test everyone of the volley ball skill tests used in this study showed a significant relationship with the criterion. Any one of five tests would determine to a certain degree the ability to play volley ball on the part of eighth grade boys. The best single test of volley ball ability on the basis of degrees of r was the repeated volley test. This was followed closely by the set-up test, the other tests ranging not too far behind.

Inter-Correlations of Tests Used

Each skill test was correlated with every other skill as well as with the criterion. If the r between two skill tests is highly significant it would indicate that both tests were testing much the same thing. If this is true there is little reason for using both of the skill tests. It would be best to use the test which has the highest r with the criterion.

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36. See page 20 appendix
37. See page 30 appendix

Serve Test with Set-Up Test:

Correlating the serve test with the set-up test we find r = .31.[38] This r is significant at the .05 level, but not significant at the .01 level. This indicated that there is not a great deal of relationship between the serve as tested by the serve test and the set-up as tested by the set-up test.

Serve Test with Pass Test:

The coefficient of correlation between the serve and the pass test is 33.[39] Using the Null Hypothesis Theory to determine its significance we find that it is significant at the .05 level, and not significant at the .01 level. Although there is a relationship between the two tests; perhaps the tests measure some different aspect.

Serve Test with Spike Test:

An r of .44[40] indicates a definite relationship between the serve test and spike test as r is significant at both the .05 and .01 levels. These two tests are evidently measuring much the same thing.

Serve Test with Repeated Volley Test:

The coefficient of correlation between these two tests is .49,[41] showing a significant relationship between the two tests. Using both these tests as a test of volley ball ability would be superfluous as both perform the same function.

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38. See page 22 appendix
39. See page 23 appendix
40. See page 23 appendix
41. See page 23 appendix

Serge Test and Net Recovery Test:

Between these two tests an r of .213[42] exists. As this r is not significant at either the .05 or .01 levels, they are evidently performing different functions.

Set-Up Test with Pass Test:

The inter-correlation of these two tests (r = .49)[43] produces a significant relationship, which shows that both tests are testing much the same abilities. Use of one test is sufficient to determine volley ball playing ability.

Set-Up Test with Spike Test:

In correlating the spike test and the set-up test an r of .55[44] is found. This r is very significant, showing a considerable relationship between the two tests. Both tests are testing the same ability to a large degree, and use of both would be unnessary.

Set-Up Test with Repeated Volley Test:

An r of .60[45] is found when these two tests are correlated. Using the Null Hypothesis Theory this r is found to be highly significant at both the .05 and .01 levels, indicating that both tests measure the same abilities. As it would be unnessary to use both, the repeated volley test would be the best as it produces the highest r when correlated with the criterion.

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42. See page 24 appendix
43. See page 25 appendix
44. See page 26 appendix
45. See page 26 appendix

Set-Up Test with Net Recovery Test:

A coefficient of .30[46] is found when these two tests are correlated. This r is significant at the .05 level but not significant at the .01 level. From this we may conclude that the two tests are testing different abilities.

Pass Test and Spike Test:

The r of .53[47] existing between the pass test and spike test is also highly significant. Therefore, one test only would be needed to determine the volley ball ability of eighth grade boys.

Pass Test with Repeated Volley Test:

The coefficient of correlation between these two tests is also .53.[48] This r is highly significant at both the .05 and .01 levels, indicating that passing ability as tested by the repeated volley test are closely related. As a test of volley ball ability these two tests are too highly related to use both. Because a higher r was found between the repeated volley test and the criterion, that would be the logical test to use.

Pass Test with Net Recovery Test:

When these two tests are correlated r = .10.[49] This is not significant at either the .05 or .01 levels, indicating these two tests measure different abilities. As a measure of volley ball playing ability the pass test would be used, as the r found between the net recovery test and the criterion is not significant.

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46. See page 26 appendix
47. See page 27 appendix
48. See page 27 appendix
49. See page 27 appendix

Spike Test with Repeated Volley Test:

A coefficient of correlation of .548[50] is obtained between the spike test and the repeated volley test. Based upon the Null Hypothesis Theory this r is found to be highly significant, showing a considerable relationship between the two tests. As the repeated volley test produces a higher r when correlated with the criterion it is the better test to use when measuring volley ball playing ability.

Spike Test with Net Recovery Test:

Lowest r found between two tests was the .07[51] obtained when correlating the spike test and the net recovery test. This low r indicates that there is little relationship between the abilities measured by the two tests.

Repeated Volley Test with Net Recovery Test:

The r of .17[52] found between these two tests is not significant at either the .05 or .01 levels. We can conclude from this that there is little relationship between the skills measured by the two tests.

Summary:

These correlations indicate that the net recovery tests and the other skill tests used in the battery bear little relationship. However, it would be impractical to use the net recovery test in combination with other tests as it has little relationship to volley ball playing ability as shown by an insignificant r.

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50. See page 28 appendix
51. See page 28 appendix
52. See page 29 appendix

The serve test showed no relationship with the set-up and pass tests at the .01 level. A combination of the serve test with either the pass or set-up tests should be tried as they have a high validity coefficient and minimum relationship with the serve test. This would mean that each test measures the desired ability, but that each test measures some element of the total not measured by the serve test.

All other combinations are significant at both the .05 and .01 levels, indicating that they test similar abilities. Use of a combination of several of these tests might result in a more valid measure but would be uneconomical of time.

Test Selection.

The final step in the study was to select from the skills tests used the most valid battery of tests, those tests which will predict the ability to play volley ball most efficiently. The Wherry-Doolittle Test Selection Method is used for this purpose. This method selects the tests of the battery analytically and adds to them one at a time until a maximum R is reached.

Selected as the first test of the battery was the repeated volley test. This test produced an R of .8460 or .85,[53] the correlation of the repeated volley test with the criterion.

The second test selected is the set-up test which produced multiple coefficient R of .8683 or .87.[54] This is a substantial gain, so the set-up test is added to our battery.

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53. See page 31-35 appendix
54. See page 31-35 appendix

Third test selected is the serve test, which produces an R of .8865 or .89[55] which is larger than the .8683 found for the repeated volley and set-up tests. Therefore, the serve test is added to our battery.

Using the pass test as the fourth test, R is increased from .8865 or .89 to .8886 or .89.[56] The increase in R is so small, however, that it is hardly profitable to enlarge the battery by a fifth test.

A fifth test also was added, the spike test, which increased the r to .8894 or .89.[57] This increase was also so small that it is not profitable to add the test to our battery.

Three tests really constitute the battery which has the highest validity of any combination of tests. These are as follows; the repeated volley test, the set-up test, and the serve test. Although the addition of the pass test and spike test increase the R, they do so by such a small amount it is hardly necessary to add these tests to the batter.

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55. See pages 31-35 appendix
56. See pages 31-35 appendix
57. See pages 31-35 appendix

CHAPTER IV

CONCLUSIONS

1. Of the six tests included in the battery only the net recovery test failed to produce a significant r with the criterion. This test is a poor measure of volley ball playing ability.

2. The best single test of volley ball playing ability of eighth grade boys is the repeated volley test. An r of .85 was obtained between this test and the criterion.

3. Second best test was the set-up test. An r of .68 was obtained between this test and the criterion.

4. Scores of both the serve and pass tests were affected by the low ceiling. Under different circumstances scores of these tests might have been different.

5. Boys who were members of the eighth grade inter-school basketball team scored the highest on the various tests. As these boys were more adept at handling the ball we might conclude that ball handling is essential to playing ability in the game of volley ball.

6. Height was an important factor in the spike test. Boys who were short in stature produced the lower scores.

7. Intercorrelations between the net recovery test and the other tests of the battery indicate that there is little significance between them. This is not surprising, as the net recovery test was not found significant when correlated with the criterion.

8. The serve test when correlated against either the pass test or set-up test produced an r which was not significant at the .01 levels. This indicates that these tests, although bearing considerable relationship to the criterion, measure different abilities than the serve test. Use of either of these tests with the serve test might produce a better picture of volley ball playing ability than when used alone.

9. All other tests when correlated with each other were shown to have considerable relationship. It would be more profitable to use these tests alone than in conjunction with each other, as they test the same abilities. The combinations are as follows:

(1) serve test with spike test.
(2) serve test with repeated volley test.
(3) set-up test with pass test.
(4) set-up test with spike test.
(5) set-up test with repeated volley test.
(6) pass test with spike test.
(7) pass test with repeated volley test.
(8) Spike test with repeated volley test.

10. The repeated volley test, set-up test, and the serve test were selected by the Wherry-Doolittle method as the most valid battery of tests, the tests which will predict the criterion most efficiently. While both the pass test and spike test increase the R, the increase is so small that neither is necessary. While the use of all three tests will give a truer picture of the ability to play volley ball, the repeated volley test is the only test necessary when the instructor finds he is limited by time.

11. Volley Ball instructors may make use of these tests in the following ways:

(1) to classify pupils for squads and intramural teams.

(2) to aid in grading students.

(3) to determine progress and needs of students.

(4) as drills to improve volley ball skills.

(5) as a measure of the instructor's teaching effectiveness.

12. The pass test, spike test, and net recovery test require further research. Scores of zero made by the boys taking the tests indicated these are poor tests. In order to be good tests all students should be able to score.

Bibliography

Books

American Association for Health, Physical Education and Recreation, Research Methods Applied to Health, Physical Education and Recreation. Washington: American Association for Health Physical Education, and Recreation, 1949.

Bassett, Gladys, Glassow, Ruth, and Locke, Mabel. "Studies in Testing Volley Ball Skills," Research Quarterly, VIII (December, 1937) p. 60.

Brady, George F., "Preliminary Investigations of Volley Ball Playing Ability." Research Quarterly, XVI (March, 1945) p. 14.

Clark, H. Harrison, The Application of Measurement to Health and Physical Education. New York: Prentice-Hall, Inc., 1947, XVI - 412 pp.

Edgren, H. D., and Robinson, G. G., Individual Skill Tests Physical Activities, pp. 18-23. Chicago: H. D. Edgren and G. G. Robinson, 1937.

French, Esther L., and Cooper, Bernice I., "Achievement Tests in Volley Ball for High School Girls." Research Quarterly, XI, (December, 1940,) p. 33.

French, Esther L., and Scott, M. Gladys, Better Teaching Through Testing, New York: A. S. Barnes and Company, 1945., VIII - 247 pp.

French, Esther, and Scott, M. Gladys, Education in Physical Education. St. Louis: C. V. Mosby Company, 1950. 344 pp.

Garrett, Henry E., Statistics in Psychology and Education. New York; Longmans, Green and Company, 1947, XII - 487 pp.

LaVega, Robert E., Volley Ball, A Man's Game. New York: A. S. Barnes and Company, 1933, XIII - 114 pp.

McCloy, C. H., Tests and Measurements in Health and Physical Education. New York: F. S. Crafts and Company, 1947, XXII - 412 pp.

Reynolds, Herbert J., "Volley Ball Tests." Journal of Health and Physical Education, I, (March, 1930) p. 42.

Russell, Naomi, and Lange, Elizabeth, "Studies in Testing Volley Ball for High School Girls." Research Quarterly, XI (December, 1940), p. 33.

Sharman, Jackson R., The Teaching of Physical Education, pp. 224-231 New York: A. S. Barnes and Company, 1936.

Voltmer, Edward F. and Esslinger, Arthur A., The Organization and Administration of Physical Education, pp. 422-433. New York: F. S. Crafts and Company, 1947.

APPENDIX

Scorecard Used By Judges

To Rate Players

TEAM NO. 1

Name	Shirt No.	5	4	3	2	1	Score
J. Smith	5						
T. Jones	12						
R. Larson	20						
T. Peterson	18						
C. Hill	6						
H. Lowe	3						

Superior - 5

Above Average - 4

Average - 3

Below Average - 2

Poor - 1

INSTRUCTIONS FOR RATING ABILITY OF VOLLEY BALL PLAYERS

Rate the players in five separate categories as follows:

Superior - 5 points

Above Average - 4 points

Average - 3 points

Below Average - 2 points

Poor - 1 point

When rating the players attempt to use all five categories. The ratings should be a judgement of each boy's ability in relation to the groups, not a general rating.

Each judge should give an independent rating to each player, therefore judges should be on separate sides of the court. Ability of the players should not be discussed until the ratings are finished.

Four teams will be rated each night. Each team will play three games. The first two games will be played by all four teams; following this, teams will play their last two games consecutively.

Every team will have a separate score card. On this scorecard you will find the following information: the players name; the number of his shirt; and five columns headed by the numbers 5, 4, 3, 2, and 1. The numbers at the top of the columns correspond to the rating categories. If you think the player is superior place a check mark opposite his name in the column headed by 5. All other ratings will be made in a similar manner.

FREQUENCY TABLE FOR THE SERVE TEST

Scores	f	d	fd	fd^2
60-64	2	7	14	98
55-59	0	6	0	0
50-54	0	5	0	0
45-49	1	4	4	16
40-44	2	3	6	18
35-39	2	2	4	8
30-34	13	1	13	13
25-29	11	0		
20-24	5	-1	-5	5
15-19	6	-2	-12	24
10-14	6	-3	-18	54
5-9	1	-4	-4	16
0-4	1	-5	-5	25
	50		-3	277

Calculation of the Median, Mean, Standard Deviation, Standard Error of the Mean, and Standard Error of the Standard Deviation for the Serve Test.

(1) Median = $\frac{N}{2} = \frac{50}{2} = 25$

Median = 24.5 plus $\frac{6}{11} \times 5 = 27.23$

(2) Mean (Short Method) : G.A. plus $\left(\frac{\text{Sum of Fd}}{N} \times \text{S.I.}\right)$

G.A. = 27.5 27.5 plus $\left(\frac{-3}{50} \times 5\right) =$

$\frac{\text{Sum of Fd}}{N} = \frac{-3}{50}$ 27.5 plus (-.3) = 27.2

(3) Standard Deviation

$$\text{Standard Deviation} = \sqrt{\frac{\text{Sum of Fd}^2}{N} - \left(\frac{\text{Sum of Fd}}{N} \times \text{S.I.}\right.}$$

$\frac{\text{Sum of Fd}^2}{N} = \frac{277}{50} = 5.54$

$\frac{(\text{Sum of Fd})^2}{N} = \left(\frac{-3}{50}\right) = (-.06)^2 = .0036$

$$= \sqrt{5.54 - .0036} \times 5$$

Standard Deviation = 11.75

(4) Standard Error of the Mean

$$\text{Standard Error of the Mean} = \frac{\text{S.D.}}{\sqrt{50}}$$

$$\text{Standard Error of the Mean} = \frac{11.75}{7.071}$$

Standard Error of the Mean = 1.66

99% of cases fall between ± 2.58 S.E. of Mean

(5) Standard Error of the Standard Deviation

$$\text{Standard Error of the Standard Deviation} = \frac{\text{S.D.}}{\sqrt{2(N-1)}}$$

$$\text{S.E. of S.D.} = \frac{11.75}{9.899} = 1.187$$

Accuracy limit for (N-1) = 49 at .01 is 2.682

FREQUENCY TABLE FOR THE SET UP TEST

Scores	f	d	fd	fd^2
75-79	1	9	9	81
70-74	1	8	8	64
65-69	0	7	0	0
60-64	1	6	6	36
55-59	0	5	0	0
50-54	4	4	16	64
45-49	4	3	12	36
40-44	4	2	8	16
35-39	10	1	10	10
30-34	4	0		
25-29	4	-1	-4	4
20-24	5	-2	-10	20
15-19	1	-3	-3	9
10-14	7	-4	-28	112
5- 9	3	-5	-15	75
0- 4	1	-6	-6	36
	50		+3	563

Calculation of the Median, Mean, Standard Deviation, Standard Error of the Mean, and Standard Error of the Standard Deviation for the Set Up Test.

(1) Median = $\frac{N}{2} = \frac{50}{2} = 25$

Median = 29.5 plus $\frac{4}{17} \times 5 = 34.5$

(2) Mean = G.A. plus $\left(\frac{\text{Sum of fd}}{N} \times \text{S.I.}\right)$

G.A. = 32 32 plus $\left(\frac{3}{50} \times 5\right) =$

$\frac{\text{Sum of fd}}{N} = \frac{3}{50}$ 32 plus (.3) = 32.3

(3) Standard Deviation

$$\text{S.D.} = \sqrt{\frac{\text{Sum of fd}^2}{N} - \left(\frac{\text{Sum of fd}}{N}\right)^2} \times \text{S.I.}$$

$\frac{\text{Sum of fd}^2}{N} = \frac{563}{50} = 11.26$

$\left(\frac{\text{Sum of fd}}{N}\right)^2 = \left(\frac{3}{50}\right)^2 = (.06)^2 = .0036$

$= \sqrt{11.26 - .0036} \times 5$

$= 3.36 \times 5 = 16.80$

(4) Standard Error (S.E.) Of the Mean.

$$\text{S.E. mean} = \frac{\text{Standard Deviation}}{\sqrt{N}}$$

$$\text{S.E. mean} = \frac{16.80}{7.071}$$

S.E. mean = 2.37

99% Of cases fall between ± 2.58 S.E. of Mean

(5) Standard Error of the Standard Deviation

$$\text{S.E. of S.D.} = \frac{\text{S.D.}}{\sqrt{2(N-1)}}$$

$$\text{S.E. of S.D.} = \frac{16.80}{9.899} = 1.70$$

Accuracy limit for $(N - 1) = 49$ at .01 is 2.682

FREQUENCY TABLE FOR THE PASS TEST

Scores	f	d	fd	fd^2
24-25	1	10	10	100
22-23	0	9	0	0
20-21	0	8	0	0
18-19	0	7	0	0
16-17	2	6	12	72
14-15	2	5	10	50
12-13	4	4	16	64
10-11	2	3	6	18
8- 9	2	2	4	8
6- 7	10	1	10	10
4- 5	10			
2- 3	9	-1	-9	9
0- 1	8	-2	-16	32
	50		43	363

Calculation of the Median, Mean, Standard Deviation, Standard Error of the Mean, and Standard Error of the Standard Deviation for the Pass Test.

(1) Median = $\frac{N}{2}$ = 25

Median = 3.5 plus $\frac{8}{10}$ x 2 = 5.1

(2) Mean = C.A. plus ($\frac{\text{Sum of fd}}{N}$ x S.I.) =

C.A. = 4.5 4.5 plus ($\frac{43}{50}$ x 2) =

$\frac{\text{Sum of fd}}{N}$ = $\frac{43}{50}$ 4.5 plus (1.72) = 6.22

(3) Standard Deviation

S.D. = $\sqrt{\frac{\text{Sum of fd}^2}{N} - \left(\frac{\text{Sum of fd}}{N}\right)^2}$ x S.I.

$\frac{\text{Sum of fd}^2}{N}$ = $\frac{363}{50}$ = 7.26

$\left(\frac{\text{Sum of fd}}{50}\right)^2$ = $\left(\frac{43}{50}\right)^2$ = $(.86)^2$ = .74

$\sqrt{7.26 - .74}$ x 2

2.55 x 2 = 5.10

(4) Standard Error (S.E.) of the Mean

S.E. Mean = $\frac{\text{Standard Deviation}}{\sqrt{N}}$

S.E. Mean = $\frac{5.10}{.7071}$

S.E. Mean = .720

99% Of cases fall between ± 2.58 S.E. of Mean

(5) Standard Error of the Standard Deviation

$$\text{S.E. of S.D.} = \frac{\text{Standard Deviation}}{\sqrt{2(N-1)}}$$

$$\text{S.E. of S.D.} = \frac{5.10}{9.899} = .515$$

Accuracy limit for $(N - 1) = 49$ at .01 is 2.682

FREQUENCY TABLE FOR THE SPIKE TEST

Scores	f	d	fd	fd^2
90-95	1	13	13	169
84-89	0	12	0	0
78-83	0	11	0	0
72-77	0	10	0	0
66-71	0	9	0	0
60-65	1	8	8	64
54-59	1	7	7	49
48-53	0	6	0	0
42-47	1	5	5	25
36-41	0	4	0	0
30-35	3	3	9	27
24-29	4	2	8	16
18-23	3	1	3	3
12-17	12			
6-11	11	-1	-11	11
0 - 5	13	-2	-26	52
	50		16	416

Calculation of the Median, Mean, Standard Deviation, Standard Error of the Mean, and Standard Error of the Standard Deviation of the Spike Test.

(1) Median $= \frac{N}{2} = \frac{50}{2} = 25$

Median $=$ 11.5 plus $\frac{1}{12} \times 6 = 12$

(2) Mean $=$ G.A. plus $\left(\frac{\text{Sum of fd}}{N} \times \text{S.I.}\right) =$

G.A. $=$ 14.5 14.5 plus $\left(\frac{16}{50} \times 6\right) =$

$\frac{\text{Sum of fd}}{N} = \frac{16}{50}$ 14.5 plus (1.92) $=$ 16.42

(3) Standard Deviation

$$\text{S.D.} \quad \sqrt{\frac{\text{Sum of fd}^2}{N} - \left(\frac{\text{Sum of fd}}{N}\right)^2} \times \text{S.I.}$$

$\frac{\text{Sum of fd}^2}{N} = \frac{416}{50} = 8.32$

$\left(\frac{\text{Sum of fd}}{50}\right)^2 = \left(\frac{16}{50}\right)^2 = (.3)^2 = .1024$

$\sqrt{8.32 - .09} \times 6$

$2.87 \times 6 = 17.22$

(4) Standard Error (S.E.) of the Mean

$$\text{S.E. mean} = \frac{\text{Standard Deviation}}{\sqrt{N}}$$

$$\text{S.E. mean} = \frac{17.22}{\sqrt{50}}$$

S.E. mean $= 2.433$

99% of cases fall between $\pm$ 2.58 S.E. Mean.

(5) Standard Error of the Standard Deviation

$$\text{S.E. of S.D.} = \frac{\text{S.D.}}{\sqrt{2(N-1)}}$$

$$\text{S.E. of S.D.} = \frac{17.22}{9.899} = 1.740$$

Accuracy limit for (N - 1) = 49 at .01 is 2.682

FREQUENCY TABLE FOR THE REPEATED VOLLEY TEST

Scores	f	d	fd	fd^2
145-154	1	6	6	36
135-144	1	5	5	25
125-134	2	4	8	32
115-124	3	3	9	27
105-114	6	2	12	24
95-104	7	1	7	7
85- 94	11	0	0	0
75- 84	3	-1	-3	3
65- 74	8	-2	-16	32
55- 64	4	-3	-12	36
45- 54	3	-4	-12	48
35- 44	1	-5	-5	25
	50		-1	295

Calculation of the Median, Mean, Standard Deviation, Standard Error of the Mean, and Standard Error of the Standard Deviation for the Repeated Volley Test.

(1) Median = $\frac{N}{2} - \frac{50}{2} = 25$

Median = 84.5 plus $\frac{6}{11}$ x 10 = 89.954

(2) Mean (Short Method)

G.A. plus $\left(\frac{\text{Sum of fd}}{N} \times \text{S.I.}\right)$

G.A. = 89.5 plus $\left(\frac{-1}{50} \times 10\right)$

89.5 plus (-.2) = 89.3

(3) Standard Deviation

$$\text{S.D.} = \sqrt{\frac{\text{Sum of fd}^2}{N} - \left(\frac{\text{Sum of fd}}{N}\right)^2} \times 10$$

$\frac{\text{Sum of fd}^2}{N} = \frac{295}{50} = 5.9$

$\left(\frac{\text{Sum of fd}}{N}\right)^2 = \left(\frac{-1}{50}\right)^2 = (-.02)^2 = .0004$

$\text{S.D.} \sqrt{5.9 - .0004} \times 10$

= 2.43 x 10 = 24.30

(4) Standard Error (S.E.) of the Mean.

$$\text{S.E. mean} = \frac{\text{Standard Deviation}}{\sqrt{N}}$$

S.E. mean = $\frac{24.30}{7.071}$

S.E. mean = 3.436

99% Of cases fall between ± 2.58 S.E. of Mean

(5) Standard Error of the Standard Deviation

$$\text{S.E. of S.D.} = \frac{\text{Standard Deviation}}{\sqrt{2(N-1)}}$$

$$\text{S.E. of S.D.} = \frac{24.30}{9.899} = 2.45$$

Accuracy limit for $(N - 1) = 49$ at .01 is 2.682

FREQUENCY TABLE FOR THE NET RECOVERY TEST

Scores	f	d	fd	fd^2
10	1	4	4	16
9	11	3	33	99
8	7	2	14	28
7	6	1	6	6
6	7			
5	8	-1	-8	8
4	4	-2	-8	16
3	1	-3	-3	9
2	2	-4	-8	32
1	2	-5	-10	50
0	1	-6	-6	36
	50		14	300

Calculation of the Median, Mean, Standard Deviation, Standard Error of the Mean, and Standard Error of the Standard Deviation for the Net Recovery Test.

(1) Median = $\frac{N}{2} = \frac{50}{2} = 25$

Median = 6 plus $\frac{7}{7} \times 1 = 7$

(2) Mean

G.A. plus $\left(\frac{\text{Sum of fd}}{N} \times \text{S.I.}\right)$

G.A. = 6.5 $\quad 6.5\left(\frac{14}{50} \times 1\right) =$

$\frac{\text{Sum of fd}}{N} = \frac{14}{50}$ $\quad 6.5$ plus $(.28) = 6.78$

(3) Standard Deviation

$\text{S.D.} = \sqrt{\frac{\text{Sum of fd}^2}{N} - \left(\frac{\text{Sum of fd}}{N}\right)^2} \times \text{S.I.}$

$\frac{\text{Sum of fd2}}{N} = \frac{300}{50} = 6$

$\left(\frac{\text{Sum of fd}}{2}\right)^2 = \left(\frac{14}{50}\right)^2 = (.28)^2 = .0784$

$\sqrt{6 - .0784} =$

$2.43 \times 1 = 2.43$

(4) Standard Error (S.E.) of the Mean.

$\text{S.E. mean} = \frac{\text{Standard Deviation}}{\sqrt{N}}$

$\text{S.E. mean} = \frac{2.43}{\sqrt{50}} = .345$

S.E. mean = .343

99% of cases fall between ± 2.58 S.E. of Mean

(5) Standard Error of the Standard Deviation

$$\text{S.E. of S.D.} = \frac{\text{Standard Deviation}}{\sqrt{2(N-1)}}$$

$$\text{S.E. of S.D.} = \frac{2.43}{9.899} = .245$$

Accuracy limit for (N -1) = 49 at .01 is 2.682

SCATTERGRAM USING THE CRITERION AS X VARIABLE

AND THE SERVE AS Y VARIABLE

x variable - criterion

Y variable - serve

	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19	20-21	fy	dy	fdy	fdy^2	x^1	y^1
60-64								1 21 21	1 28 28	2	7	14	98		49
55-59										0	6	0	0		
50-54										0	5	0	0		
45-49								1 12 12		1	4	4	16	12	
40-44				1 -3 3					1 12 12	2	3	6	18	-3	12
35-39		1 -6 6					1 4 4			2	2	4	8	-6	4
30-34			2 -4 2	3 -3 1	3	3 3 1	2 4 2			13	1	13	13	-7	7
25-29		2	1	4	2	1	1			11	0	41 -44 -3			
20-24		2 6 3		1 1 1	1	1 -1 1				5	-1	-5	-5	-1	7
15-19	1 8 8	1 6 6	1 4 4		3					6	-2	-12	24		18
10-14	1 12 12		1 6 6	1 3 3	3					6	-3	-18	54		21
5-9		1 12 12								1	-4	-4	16		12
0-4			1 10 10							1	-5	-5	25		10
fx	2	7	6	10	12	5	4	2	2	50		-3	277	-17	152 -17 135
dx	-4	-3	-2	-1		1	2	3	4						
fdx	-8	-21	-12	-10	-51	5	8	6	8	-51 27 -24					
fd^2x	32	63	24	10		5	16	18	32	200					

CORRELATION OF THE SERVE TEST WITH THE CRITERIA AND OTHER SKILL TESTS

The Pearson product-moment method of correlation was used to obtain r. Scattergrams similar to Table I were constructed for all correlations.

The formula for r is $\dfrac{\text{Sum of } x\,y - \frac{(cx)(cy)}{n}}{(\text{Sigma } x)(\text{Sigma } y)}$

1. Correlation using the Serve Score as the y variable and the Criteria Score as the x variable.

$cy = \frac{-3}{50} = -.06$ $\qquad cy^2 = .0036$

$cx = \frac{-24}{50} = .48$ $\qquad cx^2 = .2034$

Sigma y = 2.353

Sigma x = 1.941

$$r = \frac{\frac{135}{50} - (.48)(.06)}{(1.941)(2.353)} = .585$$

2. Correlation between Serve Test and Set Up Test.

$cy = \frac{3}{50} = .06$ $\qquad cy^2 = .0036$

$cx = \frac{-3}{50} = -.06$ $\qquad cx^2 = .0036$

Sigma y = 3.355

Sigma x = 2.353

$$r = \frac{\frac{124}{50} - (.06 \times .06)}{(2.353)(3.355)} = .3136$$

3. Correlation between Serve Test and Pass Test.

$cy = \frac{43}{50} = .86$ $\qquad cy^2 = .7396$

$cx = \frac{-3}{50} = .06$ $\qquad cx^2 = .0036$

Sigma y = 2.554

Sigma x = 2.353

$$r = \frac{\frac{100}{50} - (.86)(.06)}{(2.353)(2.554)} = .3254$$

4. Correlation between Serve Test and Spike Test.

$cy = .32$ $\qquad cy^2 = .1024$

$cx = .06$ $\qquad cx^2 = .0036$

Sigma y = 2.867

Sigma x = 2.353

$$r = \frac{\frac{164}{50} - (.06)(.32)}{(2.353)(2.867)} = .4370$$

5. Correlation between Serve Test and Repeated Volley Test.

$cy \ \frac{-1}{50} = -.02$ $\qquad cy^2 = .0004$

$cx \ \frac{-3}{50} = -.06$ $\qquad cx^2 = .0036$

Sigma y = 2.429

Sigma x = 2.353

$$r = \frac{\frac{141}{50} - (.02)(.06)}{(2.353)(2.429)} = .493$$

6. Correlation between Serve Test and Net Recovery Test.

$cy = \frac{14}{50} = .28$ $\qquad cy^2 = .0784$

$cx = \frac{-3}{50} = .06$ $\qquad cx^2 = .0036$

Sigma y = 2.433

Sigma x = 2.353

$$r = \frac{\frac{109}{50} - (.06)(.28)}{(2.353)(2.433)} = .3778$$

CORRELATION OF THE SET UP TEST WITH THE

CRITERIA AND OTHER SKILL TESTS.

The Pearson-product-moment method of correlation was used to obtain r.

1. Correlation between Set Up Test and the Criteria.

$cy = \frac{3}{50} = .06 \qquad cy^2 = .0036$

$cx = \frac{-24}{50} = -.48 \qquad cx^2 = .2304$

Sigma y = 3.355

Sigma x = 1.941

$$r = \frac{\frac{222}{50} - (.48)(.06)}{(1.941)(3.355)} = .6774$$

2. Correlation using Set Up Test as x variable and Pass Test as y variable.

$cy = \frac{43}{50} = .86 \qquad cy^2 = .7396$

$cx = \frac{3}{50} = .06 \qquad cx^2 = .0036$

Sigma y = 2.554

Sigma x = 3.355

$$r = \frac{\frac{212}{50} - (.06)(.86)}{(3.355)(2.553)} = .489$$

3. Correlation using Set Up Test as x variable and Spike Test as the y variable.

$cy = \frac{16}{50} = .32$ $\quad cy^2 = .1024$

$cx = \frac{3}{50} = .06$ $\quad cx^2 = .0036$

Sigma y = 2.867

Sigma x = 3.355

$$r = \frac{\frac{264}{50} - (.06)(.32)}{(2.867)(3.355)} = .5469$$

4. Correlation using Set Up Test as x variable and Repeated Volley Test as y variable.

$cy = \frac{-1}{50} = .02$ $\quad cy^2 = .0004$

$cx = \frac{3}{50} = .06$ $\quad cx^2 = .0036$

Sigma y = 2.429

Sigma x = 3.355

$$r = \frac{\frac{246}{50} - (.02)(.06)}{(2.429)(3.355)} = .6035$$

5. Correlation using Set Up Test as x variable and Net Recovery Test as y variable.

$cy = \frac{12}{50} = .28$ $\quad cy^2 = .0784$

$cx = \frac{3}{50} = .06$ $\quad cx^2 = .0036$

Sigma y = 2.433

Sigma x = 3.335

$$r = \frac{\frac{124}{50} - (.06)(.28)}{(2.433)(3.335)} = .3035$$

CORRELATION OF THE PASS TEST WITH THE CRITERIA AND OTHER SKILL TESTS.

1. Correlation between Pass Test and Criteria.

$cy = .86$ $\quad cy^2 = .7396$

$cx = .48$ $\quad cx^2 = .2304$

Sigma y = 2.554

Sigma x = 1.941

$$r = \frac{\frac{128}{50} - (.48)(.86)}{(1.941)(2.554)} = .4330$$

2. Correlation between Pass Test and Spike Test.

$cy = .32$ $\quad cy^2 = .1024$

$cx = .86$ $\quad cx^2 = .7396$

Sigma y = 2.867

Sigma x = 2.554

$$r = \frac{\frac{206}{50} - (.32)(.86)}{(2.554)(2.867)} = .525$$

3. Correlation between Pass Test and Repeated Volley Test.

$cy = .02$ $\quad cy^2 = .0784$

$cx = .86$ $\quad cx^2 = .7396$

Sigma y = 2.429

Sigma x = 2.554

$$r = \frac{\frac{165}{50} - (.02)(.86)}{(2.554)(2.429)} = .529$$

4. Correlation between Pass Test and Net Recovery Test.

$cy = .28$ $\quad cy^2 = .0784$

$cx = .86$ $\quad cx^2 = .7396$

Sigma y = 2.433

Sigma x = 2.554

$$r = \frac{\frac{43}{50} - (.86)(.28)}{(2.433)(2.554)} = .0996$$

CORRELATION OF THE SPIKE TEST WITH THE CRITERIA AND OTHER SKILL TESTS.

1. Correlation using the Criteria as x variable and the Spike Test as y variable.

$\sigma y = .32$ $\quad \sigma y^2 = .1024$

$\sigma x = .48$ $\quad \sigma x^2 = .2304$

Sigma y = 2.867

Sigma x = 1.941

$$r = \frac{\frac{173}{50} - (.32)(.48)}{(1.941)(2.867)} = .5941$$

2. Correlation using Spike Test as x variable and Repeated Volley Test as y variable.

$\sigma y = .02$ $\quad \sigma y^2 = .0004$

$\sigma x = .32$ $\quad \sigma x^2 = .1024$

Sigma y = 2.429

Sigma x = 2.867

$$r = \frac{\frac{191}{50} - (.02)(.32)}{(2.867)(2.429)} = .5476$$

3. Correlation using the Spike Test as x variable and Net Recovery Test as y variable.

$\sigma y = .28$ $\quad \sigma y^2 = .0784$

$\sigma x = .32$ $\quad \sigma x^2 = .1024$

Sigma y = 2.433

Sigma x = 2.867

$$r = \frac{\frac{30}{50} - (.32)(.28)}{(2.433)(2.867)} = .0732$$

CORRELATION OF REPEATED VOLLEY TEST WITH CRITERIA AND OTHER SKILL TESTS

1. Correlation using the Criteria as x variable and the Repeated Volley Test as y variable.

$cy = -.02$ $\quad cy^2 = .0004$

$cx = .48$ $\quad cx^2 = .2304$

Sigma y = 2.429

Sigma x = 1.941

$$r = \frac{\frac{200}{50} - (.02)(.48)}{(1.941)(2.429)} = .8463$$

2. Correlation using the Repeated Volley Test as x variable and the Net Recovery Test as y variable.

$cy = .28$ $\quad cy^2 = .0784$

$cx = .02$ $\quad cx^2 = .0004$

Sigma y = 2.433

Sigma x = 2.429

$$r = \frac{\frac{60}{50} - (.02)(.28)}{(2.429)(2.433)} = .1681$$

CORRELATION OF NET RECOVERY TEST

WITH CRITERIA

The pearson product-moment method was used to obtain r.

The formula for r is $$\frac{\text{Sum of } x^1y^1 - cx\ cy}{(\text{Sigma } x)\ (\text{Sigma } y)}$$

$cy = .28$ $\qquad cy^2 = .0784$

$cx = .48$ $\qquad cx^2 = .2304$

Sigma y = 2.433

Sigma x = 1.941

$$r = \frac{\frac{57}{50} - (.28)(.48)}{(1.941)(2.433)} = .2129$$

WORK SHEETS OF WHERRY-DOOLITTLE

METHOD OF TEST SELECTION

TABLE 1

Intercorrelations of Six

Tests and Criterion

	Ser.	Set Up	Pass	Spike	R. V.	R. N.
	1	2	3	4	5	6
0	.585	.677	.433	.594	.846	.213
1		.314	.325	.437	.493	.378
2			.489	.547	.604	.304
3				.525	.529	.100
4					.548	.073
5						.168

TABLE II

	1	2	3	4	5	6
V_1	-.585	-.677	-.433	-.594	-.846	-.213
V_2	-.168	-.166	.015	-.130		-.071
V_3	-.164		.059	-.074		-.018
V_4			.072	-.039		.045
V_5				-.057		.052

TABLE III

	1	2	3	4	5	6
z_1	1.000	1.000	1.000	1.000	1.000	1.000
z_2	.757	.635	.720	.700		.972
z_3	.757		.675	.627		.907
z_4			.670	.595		.797
z_5				.554		.790

TABLE IV

Tests

a	b $\frac{V_m^2}{zm}$	c K^2	d $\frac{N-1}{N-m}$	e $\frac{}{K^2}$	f R^2	g $\overline{R}$	Test #
0		1.000		N - 50			
1	.7157	.2843	1.000	.2843	.7157	.8460	5
2	.0434	.2409	1.021	.2460	.7540	.8683	2
3	.0355	.2054	1.043	.2142	.7858	.8865	1
4	.0078	.1976	1.065	.2104	.7896	.8886	3
5	.0058	.1918	1.089	.2089	.7911	.8894	5

TABLE V

	Tests								
	1	2	3	4	5	6	-C	Check Sum	Test #
1 A									
1 B	.493	.604	.529	.548	1.000	.168	-.846	2.496	5
1 C	-.493	-.604	-.529	-.548	-1.000	-.168	.846	-2.496	
2 A	.314	1.000	.489	.547	.604	.304	-.677	2.581	2
2 B	.016	.635	.169	.216		.203	-.166	1.073	
2 C	-.025	-1.000	-.266	-.340		-.320	.261	-1.690	
3 A	1.000	.314	.325	.437	.493	.378	-.585	2.362	
3 B	.757		.060	.162		.289	-.164	1.104	1
3 C	-1.000		-.079	-.214		-.382	.217	-1.458	
4 A	.325	.489	1.000	.525	.529	.100	-.433	2.535	
4 B			.670	.165		-.066	.072	.841	
4 C			-1.000	-.246		.099	-.108	-1.255	