Chapter II

REVIEW OF RELATED LITERATURE

A review of literature related to the present study on the investigation of certain anthropometric, behavioural and physiological factors as predictors of success in learning front crawl stroke swimming, available in the library of Lakshmibai National College of Physical Education, Gwalior has been presented in this chapter in abstract form to provide the background material to evaluate the significance of this study and as well as to interpret its findings.

Anthropometric Factors

Research regarding the effective ways of teaching sport skills has been concentrated to a large extent, in the concept of mechanics and methodology. As a result, in the teaching - learning situation, there has been a paucity of material on the effects of anthropometric measures on the learning experience.

Researchers attempted to classify physical education students by anthropometric measurements for the first
time in 1930's. These factors appeared to be of some value in predicting general athletic performance and some studies may be located in the literature concerning height and weight and performance. Cozens\(^1\) stated that there was no relationship between body height and weight of girls with fundamental skills achievement in a variety of sports, whereas Adams\(^2\) found little predictive value in height and weight to track and field performance of 200 junior high school girls.

Another study by Espenshade\(^3\) involved the testing of boys and girls, ranging in age from 10 to 18 years, in the 50 yards dash, standing broad jump, throw for distance, sit-ups, and pull-ups. Her results indicated low correlations, most often not significant, between the test

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performances and height and weight. When testing 1,559 college men on seven test items, Miller 4 reported that height and weight measures were satisfactory for classification purposes on the basis of low relationships obtained between these factors and the test performances.

Yacher et al. 5 found that efficient young swimmers improve their swimming speed primarily by growing taller.

Hoskins 6 conducted a study on the relationship of measurements of General Motor Capacity to the learning of specific Psychomotor skills taught in physical education classes. The subjects for this study were the members of freshmen class which entered the university of Virginia in the fall of 1932. The first week of scheduled classes in physical education was taken to administer tests to determine each student's general motor capacity.

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Beginning swimming was one of the courses taught in physical education classes during the year. The entire class was given a swimming test and those men incapable of swimming 50 yards free style were signed for beginning swimming. Each student was first taught to swim and later various water stunts were taught to the class. It was noted that some of the students learned to swim very quickly while others were slower in learning. At the conclusion of the course each student was given a test on each water stunt and a swimming test in which each student swam as far as he could. The learning scores thus obtained were correlated with the scores of general motor capacity. The results showed low correlation (.03) between learning swimming and general motor capacity. Age, height and weight appeared to be of little significance in all cases.

✓ In order to find out the individual differences in the speed of learning gross bodily motor skills Brace\(^7\) conducted a study on 89 female beginning swimmers studying in 6, 7 and 8 grades. The data on height, weight,

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Brace motor ability, and Mc Cloy's classification index was secured. Ten skills related to swimming were chosen as test items. The number of trials required by each girl, to pass the test on each skill, was recorded. T-scale score for each girl was obtained. This score was called the average learning score. It represented the number of trials required to learn all test items. The conclusions derived from the study were (1) Wide variations in individual differences were noted in the number of trials required by beginning swimmer to learn the swimming skills although, some of the learning tests were too easy, and (2) A fair relationship was noted between height-weight ratio and learning scores.

In another similar study Brace recorded the number of trials needed to perform perfectly five motor activities, namely rhythm test, field hockey test, tennis test, stunt test and volleyball test. The subjects were 275 high school girls and the data was secured on their age, height, weight, motor ability and teacher's rating. The score on each of the five tests was the number of trials

\textsuperscript{8}\textsuperscript{Ibid.}
needed to pass the test and these were converted into
t-scores which were later averaged to get the average
learning score. A wide variation in individual diffe-
rences in learning motor skills was noted. There was a
low correlation between the "learning tests" and age,
height, weight, motor ability and teacher's ratings.

Sprague\textsuperscript{9} investigated the ways of examining the
relationship of swimming speed to body measurements for
all four competitive swimming strokes. The measures of
speed included times projected from the ratios of actual
times to age group records, the age predicted residuals
of those projected times, and the derived ratios them-
selves. In addition, the actual 100 yard freestyle times
and the age predicted residuals of those times were used
as dependent variables. Independent variables were
entered in several ways and at least once as raw scores
and the residuals of age related variables were also
entered as independent variables.

The anthropometric measurements taken were height,
weight, sitting height, lower leg length, foot length, arm

\textsuperscript{9}Homer Allen Sprague, "The Relationship of Certain
Physical Measurements to Swimming Speed in Male Age Group
Swimmers," Dissertation Abstracts International 35
(January 1975): 4235-4236-A.
length, forearm length, waist girth, chest girth, hip girth, upper arm girth, thigh girth, wrist girth, ankle girth, hip width, shoulder width, and chest thickness.

The results of the study showed foot length and bicep size as the most consistent physical measures. Each was found significant in at least one analysis for each stroke. In each case longer feet were associated with slower times and larger biceps were associated with faster times.

Stevenson\(^{10}\) designed an investigation to predict the ability of elementary school children to perform and to learn a balance type skill. The predictors used were age, height, leg length and weight. The criterion variable of balance performance was measured by the time in balance on a stabilometer and stabilometer learning was measured by the average time in balance of the first two trials minus the average of the last two of the ten trials. The subjects were 129 third and fifth grade boys and girls.

The degree to which each factor was related to performance and learning on the stabilometer was calculated by zero order correlations. Multiple correlation and step-wise regression was used to predict stabilometer performance and learning. No single variable proved to have substantial predictive power for either performance or learning on stabilometer. However, prediction of the learning task as reflected by the step-wise regression, from the variables as a group was significant in case of weight.

Kansal\textsuperscript{11} studied 246 male students ranging in age from 11 to 17 years to develop scientific criteria for the selection of budding athletes based on their morphological status. Their height, weight, bi-acromial, humerus, bycondylas, chest and calf circumferences and performance in 100 meter running, shot put and standing broad jump were examined. He concluded that the measurements showed significant degree of relationship with individual performance tests studied.

In a comparative study Bharadwaj and associates concluded that presence of longer lower extremities in basketballers appears to be the effect of selection. Shorter but muscular legs in footballers are better suited to provide powerful kick to the football. Longer legs would perhaps cause earlier fatigue of the thigh muscles. Longer arms are advantageous for basketballers and wrestlers were found with lowest leg proportions.

**Behavioural Factors**

Schiltz and Levitt examined the levels of aspiration of 7 high-skilled and 7 low-skilled boys to determine if they differed under prearranged conditions of failure in a simple motor task. The subjects were selected on the basis of their skill performances on Iowa Brace Test. The motor task consisted of moving small blocks from one board to another. Preceeding each of three trials, the subject stated how many blocks he

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reasonably thought he could move in the succeeding 30 second trial. After a universal performance level was established, failure was induced by systematically stopping the subject before he attained his level of aspiration. A 2 x 3 factorial design with repeated measures on the second factor was employed. Analysis of variance indicated that the main effects of skill level and trials were significant at the .05 level. Analysis of simple effects indicated that the level of aspiration of the high and low-skilled groups differed significantly only on the third trial and that failure had a significant effect on both groups. High-skilled subjects expressed higher level of aspiration than did low-skilled subjects.

Cratty\textsuperscript{14} pointed out that an individual's performance is influenced by how well he thinks he might do when attempting a task. But this estimation of his performance fluctuates due to failure as well as to success.

The success in the task raises the individual's aspiration level. His aspiration level in turn encourages him to participate more in the successful activity.

Smith\textsuperscript{15} investigated the influence of football success and failure on the level of aspiration of the participants and found a tendency for successful players to raise their level of aspiration. Further he found that individuals expressing higher levels of aspiration maintained some hope for success while repeatedly experiencing failure, and that those with low aspiration who experienced failure overtly withdrew from failure producing situations. He also observed a tendency for those with highest levels of aspiration to experience success repeatedly, even though they raised their level of aspiration goals. Smith concluded that ultimate level of aspiration was not correlated with ultimate achievement.

Harvey\textsuperscript{16} conducted a study to investigate the relative effectiveness of four motivational techniques:


\textsuperscript{16}Dexter A.A. Harvey, "The Effects of Level of Aspiration and Team Competition as Motivational Techniques Upon Children's Performances on Selected Sports Skill Tests," Dissertation Abstracts International 31 (June 1971): 6383-A.
level of aspiration, team competition, combined level of aspiration and team competition, and control or no motivation upon the performances of fourth and fifth grade students on four sports skill tests, shuttle run, dodging run, basketball speed pass, and overhand ball throw. The subjects were randomly assigned to one of the four motivational techniques for each sports skill test. All subjects received three trials on each sports skill test under the control condition for the initial test. Two days after the initial test, subjects received three trials on each sports skill test under the treatment condition for the final test.

The analysis of covariance for randomised groups was used to secure data to help determine the effects, if any, the treatment conditions had upon children's performances on the four sports skills tests. When a significant 'f' was obtained on the analysis of covariance results, the adjusted treatment means were compared using Kramer's Modification of Duncan's New Multiple Range Test.

The findings of the study indicated that the students performing under the level of aspiration, team
competition, and combined level of aspiration and team competition motivational techniques attained their best performance on the selected sports skills. The team competition and the combined level of aspiration and team competition motivational techniques were found to be the most effective in improving children's performances.

Rosen and D'Andrade\textsuperscript{17} in their study on Psychological origins of achievement motivation concluded that people with high aspiration level perform best.

Chaloupka\textsuperscript{18} conducted a study to determine the relationship between level of aspiration and performance on psychomotor and cognitive tasks. Ninety male students of eighth class participated as volunteer subjects in the study. All subjects were tested for level of


aspiration on two gross psychomotor tasks, two fine psychomotor tasks, and a cognitive task. The motor ability scores of the subjects were determined by use of the Barrow Motor Ability Test. Academic ability scores were obtained from their school records. Correlation was employed to determine the relationship between level of aspiration and performance on the selected psychomotor and cognitive tasks. The findings of the study indicated nonsignificant correlations between aspiration discrepancy scores and performances for two gross and two fine psychomotor tasks and a cognitive task.

Clarke and Clarke\(^1\) investigated the relationship between level of aspiration and selected physical factors. Utilizing a grip-strength test, 98 nine year old boys were asked to predict future performance on the basis of knowledge of past results on each of two succeeding endeavours with a hand dynamometer. Two aspiration discrepancy scores were computed and the subjects divided into three distinct groups: those with the highest

positive scores, those with 'zero' discrepancies, and those with the greatest negative scores. The differences between the means of these groups for various physical factors were tested for significance. Results indicated that boys who expressed higher levels of aspiration were physically superior in size and strength to those who expressed neither an increase nor a decrease in their assessments.

To investigate the effect of understanding the mechanical principles upon learning of a motor skill and also to determine whether intelligence of the learner is a factor for faster motor learning Papcsy conducted a study on 120 eighth grade boys enrolled in Albuquerque Public School, New Mexico. The subjects were involved in the learning of a handball skill to a prescribed criterion level while being subjected to the 'principle inclusion method.' Later their learning performances were measured and compared. It was found that the learning rate was greater among subjects with lower intelligence

than among subjects with higher intelligence.

On the contrary, while exploring the effect of time and practice on the learning of mirror tracing skill, Harmon and Oxendine\(^{21}\) noted a significant positive correlation between general intelligence scores and performance in the mirror tracing skill.

Brace\(^{22}\) in searching for the individual differences in the speed of learning swimming skills, studied 89 female beginning swimmers of 6 to 8 grades on their intelligence scores. The results of the study showed no significant relationship between their Intelligence quotient and the speed of learning motor skills in water.

In another similar study the same author recorded the number of trials needed to learn five motor activities, namely rhythm test, field hockey test, tennis test, stunt test and volleyball test. The subjects were 275 high school girls. The results of the study indicated a low correlation between the learning tests and intelligence quotient and teacher's ratings.


\(^{22}\)Brace, Research Quarterly 12:184.
Keogf in his study on motor performance measurement problems when examining relationships of motor and intellectual functioning found that intelligence is slightly related to proficiency in physical activities at elementary, junior high school, high school and college students level.

Kulcinski investigated the effectiveness of superior, normal and subnormal intelligence quotients in learning fundamental muscular skills when the same material is presented. One hundred and five boys and girls of fifth and sixth grade served as subjects and 22 tumbling exercises were used as fundamental muscular skills. There was found a significant degree of learning by the superior group over the normal and sub-normal group, marked superiority of the normal group over the


sub-normal group, and a high degree of superiority of the superior group over the sub-normal group. A definite and positive relationship was noted between various degrees of intelligence of fifth and sixth grade boys and girls in learning of fundamental muscular skills.

Johnson\textsuperscript{25} studied the relationship that existed between physical skill as measured and the general intelligence of college students. His results indicated that there was no significant relationship between physical skill as measured and mental power or general intelligence as measured.

Oxendine\textsuperscript{26} conducted a study to determine the degree of generality and specificity in the learning of four motor skill namely, mirror tracing, a pencil maze, disc tossing, and a hopscotch-type skill. Forty junior


high school students (22 boys and 18 girls) practiced the four motor tasks for five consecutive days. Performance scores on all tasks were compared at the beginning and at several points along the learning curves to determine any degree of generality in learning or performance. Performance scores in the different tasks were also correlated with the IQ scores of the subjects obtained from the Lorge-Thorndike intelligence test. In the findings general intelligence scores showed no relationship to learning or performance ability in the skills tested.

In order to determine the relationship between success in physical education and selected attitudes Carr\textsuperscript{27} collected data from 335 high school freshmen girls who were asked to check an attitude rating scale related to physical education. The IQ scores were also used as one basis of comparison. Scores for all the subjects were obtained from their supervisor of instruction of the school. The high and low achievers were compared in respect to their attitudes held and the intelligence

\textsuperscript{27}Martha G. Carr, "The Relationship Between Success in Physical Education and Selected Attitudes Expressed by High School Freshmen Girls," \textit{Research Quarterly} 16 (October 1945):176-191.
quotient scores. The results of the study showed these factors to be effective in determining success in physical education.

To investigate the relationship between personality variables and performance categories in swimmers, Rushall administered 16 PF test to 238 swimmers from two Olympic Development Swim Clinics, Swim Clubs from California, Indiana, and New Jersey; and five college and university teams. The swimmers were pooled from the respective teams in order to form performance and maturational categories. The data were evaluated by means of stepwise multiple discriminant function analyses. Rushall concluded that the personality appeared to have no relation to success in swimming.

Whiting and Stembridge noted that those university male non-swimmers who have attended a course of

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instruction in swimming but are still unable to swim, appear to have personality characteristics affecting their ability to learn to swim. A degree of introversion might be noted, particularly by lack of confidence in themselves, fear of putting the head in the water, social inhibition, and lack of persistence both in the initial learning and later in stroke development once having learned to swim. Contrary to them those university male non-swimmers who have never received any previous instruction in swimming appear to be more confident of themselves, unafraid of the water, and very persistent in their learning attempts both in the initial stages and later in stroke development.

Behrman\(^{30}\) investigated whether there were personality differences between freshman swimmers and non-swimmers and to determine the relationship between personality traits and swimming progress among non-swimmers experiencing a common course of instruction in swimming. The subjects were compared on the basis of swimming performances, personality tests and interviews with subjects who

failed to learn how to swim. The results of the study revealed that there were significant personality trait differences between non-swimmers and swimmers and between non-learners and learners. Non-swimmers were found more shy and seclusive than swimmers, who were more sociable and outgoing. The non-swimmers had relatively poor emotional stability and poor mental health. They were hypersensitive and self-centered.

To determine the effect of increased vision and reduced anxiety on learning rates among beginning swimmers Merriman\textsuperscript{31} conducted a study on 100 male freshman college students who were divided into four experimental and one control groups. To increase vision and reduce anxiety goggles, nose clips and ear plugs were used. On experimental group used all three aids and each of the other three experimental groups used a separate aid. The control group did not use any aids. Anxiety levels were determined through administration of six sub-test of the Objective-Analytic Anxiety Battery from the institute of Personality and Ability Testing. Learning rates were

determined through skill evaluation by three expert judges.

The subjects were tested after eight hours of instruction during which the experimental groups used their aids for all instructional periods. An additional eight hours of instruction concluded the experiment. During the second half of the experimental period subjects in the experimental groups were tapered away from use of the aids. At the end of the experimental period subjects' skills were retested and anxiety levels reassessed. Data from the two testing sessions were compared by the analysis of variance statistical technique. Although increases in learning rates of the experimental groups were evidenced none were significant at the .10 level.

Burton\textsuperscript{32} explored the relationships between state anxiety, trait anxiety, achievement motivation, and skill attainment in beginning bowling and beginning riflery. Subjects for this study were 104 women students enrolled

in beginning riflery and 108 enrolled in beginning bowling. Relationships between the anxiety and achievement motivation variables and skill attainment were investigated by means of a stepwise regression analysis. The results showed that higher levels of state and trait anxiety were deleterious to learning and performance in beginning riflery, but had no effect on the level of skill attainment in beginning bowling. The need to be a success which results in emulation of the successful rather than in hard work was not related to skill attainment in either beginning riflery or beginning bowling. There was no relationship between the need to achieve through one’s own efforts and skill learning in riflery and inverse relationship was found between the need to achieve through one’s own efforts and skill attainment in beginning bowling.

To determine the efficiency of group learning under different incentive conditions and modes of activity, Cozens\(^{33}\) conducted a study on 138 collegemen.

The subjects were given preliminary tests in the six track and field events (100 yd. dash, low hurdles, half-mile run, running broad jump, 12 lb. shot put, and discus throw) before the start of the semester and final tests at the end of the semester. During the course of the semester, tests were given at regular intervals. Their performances were compared with a group of 100 men whose records were kept over a five-year period in the same events using a teaching procedure where all six events were alternated throughout the semester. It was observed that the learning curves in "big-muscle" events follow the same general tendencies as many other curves involving mental reactions and small muscle groups. The amount of improvement made in specific skills depend to some extent at least on the identical elements involved in training.

Physiological Factors

Wright\textsuperscript{34} determined the relationships between physiological readiness and the rates and efficiency of learning

gross motor skills by 112 children from 5 to 9 years of age. Three sub-concepts of physiological readiness were maturation, general motor development, and pre-requisite skill learnings. The cross-sectional samples of 14 boys and 14 girls at each of four chronological age levels (5-8 years) were administered 16 tests or measurements which operationally defined physiological readiness. Data for learning trials were collected from children on the throwing for accuracy, spatially precise jumping and kicking for accuracy learning tasks. The learning criteria for the three motor tasks were established on the basis of restricted probability models. The number of trials needed to master each task denoted the rate of learning. The mean minus gain scores were considered as the efficiency of learning the motor tasks.

Each subject received 24 daily practice trials for each of the throwing and kicking for accuracy tasks and 12 daily practice trials on the jumping tasks for 10 consecutive days. Zero-order correlations, two factor ANOVA, and step-wise multiple regression were used as statistical techniques to determine the relationship between physiological readiness and motor learning performances were tested for significance at the .05 level of
confidence. Physiological readiness was found to be significantly correlated with the rates of learning and the efficiency of learning the three tasks.

While comparing the effects of two instructional methods on acquisition of skills in beginning swimming, Robins\(^\text{35}\) further investigated the effect of floating ability in learning elementary skills. The two groups of college male students were taught swimming with the American Red Cross Method and a Modified Red Cross Method. Each group met thrice a week for 60 minutes of instructions. The tuck float was used to determine the buoyancy levels and the skinfold measurements were taken to determine the percent body fat of each subject. The results of the study showed that the non-swimmer who possessed good floating ability had a significant advantage in learning the elementary swimming skills than subjects who had poor floatability.

In order to determine the relative merits of learning to swim with a waist-type flotation device, as opposed to learning to swim with no flotation device,

Kaye\textsuperscript{36} conducted a study on 30 male students at Brooklyn College. The subjects were selected on the basis of their inability to swim and were divided into two groups for the purpose of comparing the effectiveness of the use of flotation device in learning to swim. After two aquatic orientation sessions for both groups, they were taught to swim. At the end of each session, each student in each group was tested by an outside scorer to determine the distance he could swim. Those in the experimental group were tested with the flotation device removed. At the end of the experiment improvement was noted in each group, but the group using the waist-type flotation device was able to swim farther.

In their investigation of human body dimensions and applied hydrodynamics and selection criteria for top swimmers, using 63 students from Academy of Physical Education, Amsterdam and nine Dutch competitive olympic level swimmers as subjects, Clarys and associates\textsuperscript{37}


concluded that shape, composition and dimensions of the body exert little or no influence on the hydrodynamic resistance (in independent crawl locomotion).

Rork\textsuperscript{38} conducted a study to determine the floating ability of women on a homogeneous group of 27 young adult women, all of whom were expert swimmers. Observations were made in an indoor fresh water swimming pool. The factors affecting floating ability were considered: the specific gravity of the body, its buoyancy, surface area, and vital capacity. The method used for obtaining the specific gravity of the body was based on Archimedes Principle and was calculated by dividing the weight of the body on land by the loss of weight in water. Similarly, the buoyancy was obtained by subtracting the force needed to float the legs from the weight of the body. Partial and multiple correlations between buoyancy and other factors were computed. The results obtained showed a high positive correlation between the multiple factors buoyancy, surface area, vital capacity, and specific gravity. On the basis of the findings the human floaters may be classified in two groups: (1) Those who have a small specific

gravity due to either adiposity or a large pulmonary volume
or both; and (2) those who have a large surface area.
Floating ability is greatest when all three attributes are
simultaneously present.

Sprague\textsuperscript{39} conducted a study to find out the rela-
tionship of swimming speed to the measurements of triceps
skinfold, scapular skinfold, shoulder flexion, ankle
flexion, knee extention, elbow extension and vital
capacity. The results of the study showed no correlation
between the swimming speed in all four competitive strokes
and these measurements.

Armstrong\textsuperscript{40} investigated the relationship between
general motor ability and cardiovascular endurance in
the learning of selected physical education skills of 173
community college men and women. The subjects involved in
this study were enrolled in one of the seven activity

\textsuperscript{39} Sprague, \textit{Dissertation Abstracts International}
35:4235-A.

\textsuperscript{40} Joan Armstrong, "The Effect of Motor Ability and
Endurance on Selected Physical Education Skills of College
Men and Women," \textit{Dissertation Abstracts International} 34
(March 1974):5680-A.
classes which included conditioning, field hockey, soccer, volleyball, badminton, tennis and golf. The data from three skill and three cardiovascular variables, three motor ability items and sixteen personality traits were analysed by analysis of variance, correlation, and multiple regression. The results of the study showed that the cardiovascular endurance was not related to skill achievement in classes where learning sport skills is emphasised.

In an attempt to identify the traits responsible for individual differences in ability to learn motor skills involving more or less total bodily activity, Brace conducted a study on 100 junior high school girls. Four 'sport type' learning tests given to the subjects to measure their ability to learn were wall volley, ball bounce, kick and target toss. The number of trials required for mastery of the skills were recorded along with the amount of learning. The findings showed that there was marked individual differences in ability to learn gross bodily motor skills. He concluded that the ability to learn sport skills is closely related to athletic ability and to speed, strength, agility and power.

Yacher et al.\(^{42}\) conducted a study on 25 male swimmers of varying ages to find out the value of power training and stroke training in determining the appropriate training procedures for competitive swimmers. Swimmers were tested on their strength, stroke, height, weight, segmental swimming and 50 yards swim. The required swimming velocity was acquired by measuring 5 yard interval times during the 50 yard sprints. Their swimming velocities were transferred into Froude numbers so that the swimmers could be compared independent of their length (standing height from floor to fingertips).

The results of the study suggested that: (1) strong-inefficient swimmers should emphasise more on stroke technique and not on further strength development. (2) Weaker - inefficient swimmers should train a combination of stroke technique and strength development.

To establish the relationship between motor learning and certain physical abilities Mc Craw\(^{43}\) investigated


30 variables including strength, speed, power, agility, endurance, motor ability and athletic ability which were used in the factor analysis of the study. The data was obtained on 100 seventh grade girls in the University Junior High School at the University of Texas. The ages of the subjects ranged from 10 to 14 years. The learning tests used for the study were volley test, ball bounce, target toss, tangle test, and rhythm test. In volley, ball bounce, and target toss tests the amount of learning was expressed in terms of the improvement made in performance during 30 trials. In the rhythm and tangle tests, learning was represented by the number of trials required to execute the activities correctly. The study revealed that the factors of body size, athletic ability, motor ability, and physical fitness performance were not involved in any of the five learning tests.

While investigating the relationship of measurements of general motor ability to the learning of swimming in physical education classes, Hoskins found that strength

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Hoskins, Research Quarterly 5:68.
was of little significance in the learning of swimming skills. Brace\(^{45}\) also noted a low correlation between the learning scores of gross bodily motor skills and strength.

Whitley\(^{46}\) investigated the relationship between individual differences in static leg strength, learning and fatigue resulting from practice on a new foot-twist tracking task in a sample of 60 college men. The influence of practice on individual differences was also investigated.

The task required the subject to keep a stylus tip in contact with a moving target by a precision type of twisting action with the right foot. Performance was measured as time-off-target per trial. Each subject was given 35 trials, consisting of 30 sec. work/30 sec. rest with a 5 minute rest period interpolated between trials 25 and 26 to provide for a measure of fatigue. Dynamometer

\(^{45}\) Brace, Research Quarterly 12: 184.

was used to measure the static strength of the subject's right leg in the movement position. The results of the study showed a large increase in individual differences with practice. The correlations between static leg strength, performance and learning on the new task were small and non-significant.

In another similar study Whitley\(^{47}\) studied the effects of maximising inertial resistance on performing and learning of motor tasks. One hundred twenty college men, equally divided into four groups, performed the assigned foot rotational tracking task under practice conditions. All groups were given 35 trials on the task. After a 5 minute rest, all groups performed the last 10 trials under controlled conditions. The results of the study showed significant learning occurred in all groups. The correlations between leg strength and learning were non-significant for all conditions.

Vincent\(^{48}\) conducted a study to determine the roles of strength and efficiency in the prediction of success in


physical education activity courses. Thirty seven freshman women enrolled in eight physical education activity courses were selected as subjects. The physical activities taught included badminton, basic motor skills, gymnastics, and swimming. Each subject was measured in strength by dynamometers. Partial and multiple correlations were calculated between these independent variables and success in physical education activities as measured by grades. Regression equations were formulated and tested by analysis of variance. A positive, but non-significant, relationship between success and strength was noted.]

Park\textsuperscript{49} determined whether there is any relationship between physical fitness and success in physical education activities in a normal school department. For the purpose of this study 25 men and 25 women were selected at random from the physical education freshman class. The activities used were those required of all major in physical education activities at the State Normal School Cortland, New York. Sixty five subjects were selected at random. The activities were swimming, gymnastics, dancing, play games and athletics.

\textsuperscript{49}Bessie L. Park, "Relationship Between Physical Fitness and Success in Physical Education Activities," \textit{Research Quarterly} 6 (March 1935):263.
The researcher found low correlation in all five activities. There were lack of correlation between physical fitness index and athletic award. It was concluded that athletic success for men depends on mere strength than physical fitness.

In an attempt to investigate the function of the need to achieve upon the acquisition of tumbling skill when relevant motor performance abilities and body composition variables are held constant, Donovan obtained the data from 80 subjects who were enrolled in beginning tumbling courses at the University of Houston. The dependant variable was the tumbling skill performance of the students in the classes as measured by the total number of skills successfully completed. The independent variables included the need to achieve as measured by the achievement scale of the Edwards Personal preference schedule and a second set of independent variables which included strength and flexibility. These independent variables were statistically controlled in order to assess the influence of the need to achieve upon tumbling skill acquisition.

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The findings of the study indicated that the basic abilities of strength and flexibility were related to tumbling skill learning.

In order to find out better technique for teaching beginners the forehand drive in Tennis, Greer Jr.\textsuperscript{51} conducted a study on 80 male college students who volunteered to take part in the experiment. In addition physical measures like grip strength, explosive power of shoulders, and trunk extent flexibility were chosen to correlate with the improvement scores of the subjects in an attempt to determine whether these physical traits help in the learning and improvement of the forehand drive. In the first period the pre-test scores and the scores on three tests of physical traits were obtained. Each subject then participated in 4 twenty-minute practice periods during which they stroked 60 balls tossed to them. During the final period, each subject took a post-test. The improvement scores, based on pre-test and post-test scores were obtained for each subject and were correlated with the scores on the three physical measures. No significant relationship

was found between the amount of improvement in the stationary forehand drive in tennis and grip strength, explosive shoulder power, and trunk extent flexibility.

Scott\textsuperscript{52} studied 26 senior high school male swimmers who bettered or equaled a time of 56 seconds for 100 yards crawl stroke. They were tested for the flexibility of ankle, knee, hip, trunk and shoulder followed by strength test of knee, hip, shoulder and trunk. Upon completion of tests the swimmers were timed for 100 yard kick, pull and swim. It was concluded that certain flexibility measures were significantly related to swimming time. However, it was determined that knowledge of certain flexibility and strength measures could not be used to predict 100 yards crawl stroke time.

Cureton\textsuperscript{53} conducted a study on mechanics and kinesiology of swimming (crawl stroke flutter kick).


He studied the correlation between flexibility and speed in crawl stroke. The results showed significant correlation between ankle flexibility and speed of crawl stroke swimming.

**Miscellaneous Factors**

Carlin\(^{54}\) investigated the effect of body composition upon the efficiency of water treading. The subjects were 8 trained swimmers age ranging between 9-15 years. Cardio-pulmonary responses of treading water was compared to that of treadmill walking. Physical factors under analysis were body surface area, height, weight, body density, percentage fat, and lung capacity. Analysis indicated that efficiency of treading water was best related with their body height.

Albrecht\(^{55}\) studied 89 high school level swimmers in order to investigate the relationship between certain


physique and flexibility measures and swimming success and did not find significant relationship between physique measures and swimming success.

Manly\(^{56}\) conducted a study on 11 varsity swimmers from Virginia Polytechnic Institute and State University and 10 boys who were members of several Blacksburg and Virginia area AAU Youth Group Swimming Teams, to determine the relationship of selected metabolic, pulmonary and anthropometric factors to performance in 100 yards butterfly swimming event. It was concluded that maximal breathing capacity was the only predictor in the youth group swimming performance at the .05 level of confidence. The stepwise multiple regression revealed that strength, somatotype index, bitrochantric, oxygen debt and maximal vital capacity are contributing factors to performance in 100 yards butterfly swimming event. Further, a high multiple correlation was found among four variables namely maximum breathing capacity, vital capacity, chest debt and strength to performance in 100 yards butterfly swimming.

\(^{56}\)Theodore A. Manly, "The Relationship between Performance in the Competitive Butterfly Stroke in the Male Swimmers and Selected Physiological and Anthropometric Factors," Dissertation Abstracts International 37 (October 1976);2057-A.
Relationship of selected physiological and psychological factors to the beginning swimmer's ability to perform crawl stroke was determined by Crites. He selected 40 subjects who were members of two beginning swimming classes which met for forty minutes twice a week. Prior to any swimming instruction, measurements were collected on shoulder rotation, shoulder extention strength, hip extention strength, body composition, swimming anxiety and swimming ability as measured by the Fox Power Test (revised). After five weeks of crawl stroke instruction, measurements were again collected on anxiety and swimming ability. It was concluded that shoulder rotation, shoulder extention strength, hip extention strength and body composition were not significant factors in the performance of the crawl stroke but a significant relationship was found between swimming anxiety and the ability to perform the crawl stroke.

In order to study the effects of selected biological, psychological, and sociological factors on the learning

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57 Jerry Keith Crites, "A Study of Selected Physiological and Psychological Factors to Determine Their Relationship to the Performance of the Crawl Stroke by Beginning Swimmers," Dissertation Abstracts International 36 (October 1975):2084-A.
rate of the Negro male beginning swimmer Vanderstok\textsuperscript{58} conducted a study on 37 freshmen enrolled at North California Agricultural and Technical State University, Greensboro. The biological factors was limited to the floating ability of the subject as measured by the turtle-prone float combination. The sociological factors focused on the individual's level of aspiration and certain family and environmental background data. The psychological factor of general anxiety was measured by IPAT-8-Parallel Form Anxiety Battery, and a ten point fear rating scale, developed by the investigator for this study.

An initial period was used for preliminary tests and later there were five weeks of instruction during which the front crawl was taught according to the American National Red Cross Instructor's Manual. Classes met twice a week for thirty minutes each. Performance improvement was recorded at the end of the third, fourth and fifth week by measuring the distance the subject could swim the front crawl.

Analyses of variance and correlation were the statistical techniques employed. The .05 level of confidence was accepted as indicating significance. A descriptive analysis was used to describe the sample in terms of sociological factors such as previous swimming experience, family background and desire to learn to swim. A graphic presentation was included to show the relationship between selected sociological factors, as well as a pictorial presentation of the swimming improvement over the five weeks period.

The findings of the study indicated nonsignificant correlation between the floating ability and the rate of learning swimming. Differences in anxiety did not show a statistical significant effect upon the learning rate. Fear seemed to be an important aspect of the learning rate. As fear diminished, the swimming performance improved. Level of aspiration was found to be a highly significant indicator of quicker learning.

Lemcke\textsuperscript{59} conducted a study to determine the degree of generality and specificity in the learning

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scores and also to determine the relationship of intelligence, academic achievement, muscular endurance, agility and height scores, to the learning and performance scores of the tennis, soccer, volleyball and soccer punt motor tasks.

The subjects selected for the study were 46 boys studying in fifth and sixth grades. None of the subjects had taken lessons or participated in a sports programme involving any of the four selected motor skills used in the study. The gross motor tasks selected for the study were tennis wall volley, soccer wall volley, volleyball wall volley and soccer punt. The subjects practised each of the motor tasks three trials a day for six consecutive school days.

The Pearson Product Moment Co-efficient of Correlation statistical technique was utilized to determine the relationship among task learning, task performance, and component test scores. The results indicated a low correlation between height and success in performance of the volleyball volley. The mental components of general intelligence and academic achievement showed no relationship to the learning and performance of motor tasks. There was a low to moderate relationship between agility
and the learning of the tennis and volleyball tasks. Low
to moderate relationship was also observed between muscular
endurance and the learning of tennis and volleyball tasks.

DiGiovanna\textsuperscript{60} compared Intelligence and athletic
ability of 295 college men between the ages of 18 and 21
years of the required physical education classes of the
Southern Illinois State Teacher's College. The subjects
were divided into groups for fairness in athletic competi-
tition by means of McCloys method of classification.
Their athletic achievement scores were secured by obtain-
ing individual records in standing broad jump, running
broad jump, 100 yards dash, 440 yards dash, 12-pound
shot put, javelin throw, baseball throw for distance, and
push-ups, and by converting them into a single percentage
score through the use of scoring chart. Motor ability
ratings were attained by using Brace's Motor Ability Tests.
Their ages, heights and weights were recorded to the
nearest year, inch, and pound. Intelligence quotients
were determined through the medium of Otis Self-Adminis-
tering tests of mental ability. The rank method and fool

\textsuperscript{60} Vincent G. DiGiovanna, "A Comparison of the
Intelligence and Athletic Ability of College Men," Research
Quarterly 8 (October 1937):96-104.
rule formula were employed to secure the co-efficient of correlation between intelligence quotient, athletic achievement and motor ability. It was found that: (1) There is no definite correlation between intelligence and athletic achievement, and intelligence and motor ability in college men. (2) There is a small but definite correlation (.31) between motor ability and athletic achievement. (3) Between the years 18-21, age and height have no bearing on general athletic achievement, but weight has a definite, although low correlation (.28).

In a status study made by Rossen61 on 8 champion sprint swimmers at the university of Oregon, all swimmers were found 6 feet tall, having meso-ectomorphic body build with narrow hips, wide squared shoulders, and long but thin legs. They had poor flexibility in their shoulders and ankles but had smooth and coordinated movements in the water. All of them were non-bouncy having great strength and fast reactions. They had great confidence in themselves and set higher goals than most.

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To explore the relationship between learning of a motor skill and measures of strength, motor ability, motor educability and motor capacity, Ehrlich conducted a study on 87 male students selected at random from the required physical education classes of the City College of New York. The fencing lunge was selected as the motor skill and the subjects had no previous experience in fencing. The tests used to measure the physical status of the subjects were McCloy's Motor Capacity Test, Roger's Strength Test, Larson's Indoor Motor Ability Test, and Johnson's Motor Educability Test. The group met twice a week for 12 weeks for the purpose of training and instruction in the fencing lunge, with each weekly period of 45 minutes duration. Each subject was tested once a week for the total period of 12 weeks to measure the improvement in accuracy and speed of the fencing lunge. The study revealed that measures of strength, motor ability, motor educability, and motor capacity are not related to rates of learning.

Smith studied the physical traits and abilities of 100 elementary school children (51 boys and 49 girls) in relation to their ability to learn a ball bounce and a ball toss motor skill. The ball toss for accuracy skill was practised in first 12 practice sessions and later the practice on ball bounce skill commenced at the 16th meeting. The final test was administered on 28th meeting. The physical traits and abilities selected for the study were motor ability, motor educability, dynamic balance, static balance, running speed, flexibility and strength. The analysis of learning data was based upon scores made on the two skill tests. The two learning groups were divided at the mean on each test; those above were considered fast learners and those below slow learners. Statistical significances between the fast and slow learners were determined by computing 't' ratios. Regression equations were computed in score form. The group were also compared according to sex. All of the physical and motor ability measures differentiated significantly the fast and slow learners. The boys were found superior to the girls in learning the motor skills.

For determining the learning rate of beginning swimmers and the relationship of this learning rate with motor ability Scott\textsuperscript{64} conducted a study on 20 college women non-swimmers at the University of Iowa. The subjects were taught swimming in small classes to facilitate very close records. Lessons were carefully timed to 30 minutes. Each student was asked to continue coming one lesson beyond that required to pass the 15 minute test and was permitted to continue as long as the rest of the group if she chose to do so. Lessons were terminated at 12th to 17th lesson for the slower learners. On the lesson following the passing of the test, five judges observed the swimmers and rated them on form which was considered a measure of competence in water. All swimmers not completing the test were also rated at the end of the series of lessons. Motor ability was measured by Scott Motor Ability Battery. The sum of the judge's ratings given on the 20 swimmers was correlated with the motor ability scores. The author noted some indication that motor ability was one factor

determining learning rate, but it was not sufficient to counteract all other influences. There was a great individual variation in learning rate and majority of swimmers could be taught sufficient swimming skills to pass the test in 15-16 lessons or less.

✓ For the purpose of examining the influence of programmed instruction, motor ability and academic aptitude on the learning of tennis skills, Aguilar\textsuperscript{65} conducted a study on 110 female students enrolled in four beginning tennis classes. Each student was classified as belonging to a high or low general motor ability group, as determined by the Scott Motor Ability Test. After ten weeks of treatment exposure, the students were tested for skill achievement in tennis. The statistical procedure of analysis of variance was used for this study. The results of the study showed a positive and significant effect of motor ability on the learning scores of tennis skills.

\textsuperscript{65}M. Kay Aguilar, "The Influence of Programmed Instruction on the Achievement of Specific Skills in Tennis," Dissertation Abstracts International 34 (January 1974);3951-A.
In order to examine the effects of motor ability on the learning of badminton skills, Stutters conducted a study on 99 male students enrolled in four beginning badminton classes at Southern Colorado State College. Each student was identified as belonging to a high or low motor ability, as determined by the combined items of the Barrow Motor Ability Test. A ten weeks period of treatment was imposed and the students were then tested for skill achievement in badminton. The criterion for skills achievement was the composite T scores of the French Short Serve Test and the Lockhart-McPherson Badminton Wall Volley Test. Analysis of variance and analysis of covariance were the major statistical procedures employed. The findings showed that the motor ability had a significant influence on the skill achievement in badminton.

Lafuze conducted a study on the learning of fundamental skills by college freshman women of low motor

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ability. The Scott motor ability test was administered to all physically able freshman women entering the State University of Iowa and motor ability. T-Scores were computed on the basis of which upper and lower one-fourth were selected for the study. The low motor group included 89 subjects and the high group 84. Students in these two groups were given tests in agility, balance, kinesthetic response, serial reaction time and strength. Both groups were given skills clinic in Volleyball for 16 weeks. Initial and final test scores were compared. The group with lower motor ability scores made significantly lower learning scores than those in the upper motor ability group. General motor ability and certain motor capacities could be improved by specialized instruction in the fundamental skills.

While investigating the rate of learning between two distributions of practice in archery and badminton classes, Young\textsuperscript{68} studied the effect of motor ability also on the rate of learning these two activities. Twelve

\textsuperscript{68}Olive G. Young, "Rate of Learning in Relation to Spacing of Practice Periods in Archery and Badminton," \textit{Research Quarterly} 25 (May 1954):231-242.
regular physical education students in archery and badminton of the Health and Physical Education department of Mankato State Teachers College were selected for the study. In order to measure their motor ability the Scott Motor Ability Battery was administered to women students and a modified Scott Motor Ability Battery was administered to men. The learning scores of the two activities were correlated with the motor ability scores. The students with high motor ability tended to show slightly more gain but not significant, than those with low motor ability.

To determine the influence of physical working capacity upon the amount of learning and final performance of a gross motor skill, as one of its purposes, Lay\textsuperscript{69} conducted a study on 592 male college students enrolled in physical education activity classes. The subjects were administered the Ohio State University Step Test to estimate the physical working capacity. The subjects were also administered 10 trials on the Bachman Ladder Climb which was used as the gross motor skill. The final

performance score was recorded as trial 10. The learning scores and the scores of physical working capacity were compared. The results showed that the physical working capacity did not significantly influence the amount of gross motor skill learning.

Johnson\textsuperscript{70} attempted to investigate the possibility that man's ability to learn motor tasks is associated with his physical work capacity. The study was conducted over a six-week period. Forty undergraduate women students from Smith College volunteered as subjects. All practised a double ball tossing task three times a week. Twenty subjects, members of the experimental group, concurrently participated in a physical conditioning programme that was designed to improve their physiological work capacity. The other twenty subjects, members of the control group, did not participate in the conditioning regimen. The criterion measure for physical work capacity was predicted maximal oxygen consumption as asserted by use of the Rhyming bench stepping test and the Astrand-Rhyming

nomogram. Statistical treatment of the data included a Type-I design as suggested by Lindquist and Grant's trend analysis procedure. The .05 level of confidence was accepted as indicating significance.

The findings of the study indicated no significant relationship between a person's ability to learn motor tasks and his level of physical work capacity.

Eugenia Gire and Anna Espenschade\textsuperscript{71} conducted a study to determine the relationship between the measures of motor educability and the achievement and learning by high school girls in Basketball, Volleyball, and Baseball. One hundred ninety five girls studying in a senior high school in California served as subjects. Motor educability was measured by three tests. Achievement and learning of basketball, volleyball, and baseball skills were measured by frequently repeated achievement tests at specific intervals. All achievement test scores for one sport were combined. On the basis of their final performance the subjects were divided into high and low scoring groups. The study revealed that the high scoring group was superior in all sports to the low scoring group in initial learning.