Chapter III

PROCEDURE

The selection of subjects, selection of variables, reliability of data, administration of tests and collection of data, and the statistical model for analysing the data are described in this chapter.

Selection of Subjects

The subjects for this study were 100 male students selected out of 132 swimming beginners representing various schools of Greater Gwalior and who had enrolled themselves for learning swimming in the Summer Swimming Course run every year by the investigator at the Lakshmi-bai National College of Physical Education, Gwalior for 10 weeks duration during summer, 1985. A table of random numbers was used for the selection of subjects by following the suggestions of Steel and Torrie.¹ In order to restrict the subjects to beginners, each student was

asked to indicate how much swimming instruction he had had. Those who indicated any previous experience in swimming were separated from the experimental group at the time of enrollment itself since a practical zero point of experience in the skill was desired. The health records maintained by their schools were checked by the investigator to ensure that the subjects selected were physically and mentally sound to undertake various tests chosen for this study, and were able to participate in the regular swimming teaching classes. All the subjects were residents of Greater Gwalior. The subjects ranged in age from 12.6 to 14 years with the average age of 13.7 years. The age was recorded from their school records.

Prior to testing them on different tests, a meeting of all the subjects with their parents was called. At this meeting the purpose of the study, requirement of testing procedures, demonstration and explanation of various anthropometric, behavioural and physiological tests were given in order to make them understand about what they are actually required to do to fulfill the basic requirements of this study. All the subjects agreed voluntarily to cooperate in the testing procedures explained to them. Their parents also exhorted them to put in
their best efforts in the interest of this scientific investigation. Though, no special techniques of motivation were used to motivate the subjects to put in their best efforts yet the subjects were very enthusiastic and cooperative throughout the project.

Selection of Variables

A feasibility analysis as to which of the important variables could be taken up for investigation in keeping with the availability of equipment, acceptability to the subjects and the legitimate time that could be devoted for tests as well as to keep the entire study unitary and integrated, was made on the basis of performance as gleaned from a review of professional literature and in consultation with experts. With the above criteria in mind the following variables were selected, because they seemed to be directly or indirectly related to the learning of swimming, and they were classified into two categories i.e. dependent and independent variables.

Dependent Variable

The swimming learning score denoted by the composite score calculated from the performance (timing) in 50 metres
front crawl stroke swimming and the subjective rating of
the front crawl technique by five experts, was selected
as dependent variable.

Independent Variables

The independent variables selected were classified
into three categories i.e. anthropometric, behavioural,
and physiological variables. The variables under each
category were as follows:

(A) Anthropometric Variables

1. Weight
2. Standing height
3. Foot length
4. Foreleg length
5. Thigh length
6. Leg length
7. Trunk length
8. Forearm length
9. Upperarm length
10. Arm length
11. Head circumference
12. Shoulder width
13. Upperarm girth
14. Thigh girth
15. Calf girth
16. Leg length/Trunk length
17. Foreleg length/Thigh length
18. Forearm length/Upperarm length

(B) Behavioural Variables

1. Level of aspiration
2. Intelligence
3. Concentration

(c) Physiological Variables

1. Percentage of body fat
2. Body density
3. Vital capacity
4. Aerobic capacity
5. Power
6. Arm and shoulder strength
7. Abdomen strength
8. Leg strength
9. Average ankle flexibility
10. Trunk-hip flexibility
11. Shoulder flexibility
Reliability of Data

The reliability of data was ensured by establishing the instrument reliability, tester reliability, reliability of tests and subject reliability.

Instrument Reliability

To measure selected anthropometric variables, the instruments like weighing machine, spreading caliper, flexible steel tape and wall scale were used in this study. The concentration ability of the subjects was measured by using Electrical Mirror Drawing apparatus supplied by the National Psychological Corporation, Agra. For measuring selected physiological variables, the instruments like skinfold caliper, dry spirometer, stop watches, steel tape, leg dynamometer, goniometer, yard stick, and wall scale were used. All these equipments were obtained from standard firms which cater to the needs of various research laboratories in India and abroad. All these instruments were available in the Human Performance Laboratory of Lakshmibai National College of Physical Education, Gwalior and their calibrations were accepted as accurate enough for the purpose of this study.
To test the level of aspiration the test by Dr. H.M. Singh and Dr. Govind Tiwari, supplied by the Agra Psychological Research Cell, was used. For testing the intelligence the Verbal Intelligence Test (Hindi version) by R.K. Ojha and K. Ray Choudhary which was supplied by National Psychological Corporation, Agra, was used. Both these tests were selected in consultation with Dr. Gopal Garg, Head of the Department of Psychology at M.L.B. College, Gwalior. These tests were standard tests which had high reliability²,³ and were accompanied by Indian norms.

**TESTER'S COMPETENCY AND RELIABILITY OF TESTS**

To ensure that the investigator was well acquainted with the technique of conducting the tests, the investigator had a number of trials and practice sessions with respective experts. All the measurements were taken by the investigator with the assistance of his colleagues.


who were also well acquainted with the tests and their testing procedures.

Tester competency was evaluated together with the reliability of tests. Reliability of tests was established by test-retest process whereby consistency of results was obtained by product moment correlation. The data collected from a random selection of ten subjects by test-retest process, were computed for each variable and correlations obtained have been presented in Table 1.

Since very high correlations, ranging from .827 to .991 were obtained, this establishes the investigator's competency to administer the tests as well as reliability of tests.
# TABLE 1

RELIABILITY CO-EFFICIENTS OF TEST-RETEST SCORES

<table>
<thead>
<tr>
<th>Variables/Tests</th>
<th>Co-efficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>.982*</td>
</tr>
<tr>
<td>Standing height</td>
<td>.991*</td>
</tr>
<tr>
<td>Foot length</td>
<td>.962*</td>
</tr>
<tr>
<td>Foreleg length</td>
<td>.976*</td>
</tr>
<tr>
<td>Thigh length</td>
<td>.987*</td>
</tr>
<tr>
<td>Leg length</td>
<td>.978*</td>
</tr>
<tr>
<td>Trunk length</td>
<td>.989*</td>
</tr>
<tr>
<td>Forearm length</td>
<td>.910*</td>
</tr>
<tr>
<td>Upperarm length</td>
<td>.972*</td>
</tr>
<tr>
<td>Arm length</td>
<td>.912*</td>
</tr>
<tr>
<td>Head circumference</td>
<td>.982*</td>
</tr>
<tr>
<td>Shoulder width</td>
<td>.978*</td>
</tr>
<tr>
<td>Upperarm girth</td>
<td>.984*</td>
</tr>
<tr>
<td>Thigh girth</td>
<td>.895*</td>
</tr>
<tr>
<td>Calf girth</td>
<td>.990*</td>
</tr>
<tr>
<td>Concentration</td>
<td>.898*</td>
</tr>
<tr>
<td>Skinfold measurements</td>
<td>.946*</td>
</tr>
<tr>
<td>Vital capacity</td>
<td>.829*</td>
</tr>
</tbody>
</table>
TABLE 1 (Contd.)

<table>
<thead>
<tr>
<th>Variables/Tests</th>
<th>Co-efficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Minute run/walk test</td>
<td>.827*</td>
</tr>
<tr>
<td>Vertical jump</td>
<td>.946*</td>
</tr>
<tr>
<td>Pull-ups</td>
<td>.886*</td>
</tr>
<tr>
<td>Bent knee sit-ups</td>
<td>.973*</td>
</tr>
<tr>
<td>Leg strength</td>
<td>.872*</td>
</tr>
<tr>
<td>Average ankle flexibility</td>
<td>.864*</td>
</tr>
<tr>
<td>Trunk-hip flexibility</td>
<td>.929*</td>
</tr>
<tr>
<td>Shoulder flexibility</td>
<td>.918*</td>
</tr>
</tbody>
</table>

\[ N = 10 \]
\[ r_{.01} (8) = .765 \]

*Significant at .01 level of confidence.

From Table 1 it is evident that tester reliability was significantly high thus, establishing the competency of the scholar to administer the tests. The correlation co-efficients also indicated the reliability of the tests selected since very high correlations were obtained when the tests were repeated.
Subjects Reliability

The above test-retest co-efficient of correlation method also established that subjects reliability was significant at .01 level of confidence, as the same subjects were used under similar conditions by the same tester and no motivational techniques were used nor any training given. In case of psychological variables, it was stressed that their responses will be kept confidential and these tests have nothing to do with grading in their respective classes and they should express their frank and open hearted response which suits best to their own psychological make up.

Administration of Tests and Collection of Data

The data on anthropometric, behavioural, and physiological variables was collected by administering the tests for the chosen variables during the week prior to the beginning of regular swimming classes. All the tests were administered in the Human Performance Laboratory, Gymnasium, Track and Field and Swimming Pool of Lakshmibai National College of Physical Education, Gwalior.
Before the administration of tests the subjects were given a chance to practice the prescribed tests to make them familiar with the tests and to know exactly what was to be done. The methodology for each apparatus was explained to the subjects prior to the administration of tests. To ensure uniformity in testing conditions, the subjects were tested only during the morning from 8.00 AM to 10.30 AM. However, the test for swimming learning was administered from 6.00 AM to 10.00 AM during their respective swimming hours. The data was collected for the chosen independent and dependent variables as per the procedure mentioned below:

**Anthropometric Variables**

**Weight**

The weight of the subject was taken with a standard and calibrated lever type weighing machine. The subject, bare footed wearing only the nylon swimming trunk, stood at the centre of the weighing machine. The weight was read and recorded correct to quarter of a kilogram.
Standing Height

The standing height was taken with the subject standing erect without shoes, against a marked scale on a wall touching the heels, buttocks and back. The subject was instructed to keep the heels together, head level without tilt and to take and hold a full breath while measurement was taken. A stiff hard board was held horizontally on his head, slightly pressing his head and touching the scale marked on the wall. The subject was asked to step out and the reading indicated by the hard board was read on the scale. Height was recorded correct to the nearest half centimeter.\(^4\)

Foot Length

With the subject standing, the distance between the most posterior point of the heel and the tip of the longest toe was measured with the spreading calipers. The inside edge of the fixed arm of the calipers was kept resting on the most posterior point of the heel and the moving arm of calipers was brought inward until

inside edge of the moving arm rests on the tip of the longest toe. The foot length was recorded correct to the nearest half centimetre.\textsuperscript{5}

**Foreleg Length**

Foreleg length of the subject was measured with the help of flexible steel tape vertically from the bottom outside edge of the centre of the foot to the most protruberant part of the patella bulge (coinciding with centre of the knee bend at the back). Foreleg length was recorded correct to the nearest half centimetre.\textsuperscript{6}

**Thigh Length**

Thigh length was measured vertically from the patella line to a line drawn horizontally through the mid-gluteal bulge at the point of tangency to a vertical line contacting the buttocks. The tape was placed at the centre of knee bend and measured to tip of iliac

\textsuperscript{5}Ibid., p.152.

crest. Thigh length was measured correct to the nearest half centimetre.\textsuperscript{7}

**Leg Length**

Leg length was measured vertically from the bottom outside edge of the foot in the centre of the instep to a line drawn horizontally through the mid-gluteal bulge at the point tangency to a vertical line contacting the buttocks. The tape was placed at the centre of the instep and measured to tip of iliac crest. Leg length was recorded correct to the nearest half centimetre.\textsuperscript{8}

**Trunk Length**

Trunk length of the subject was measured with a flexible steel tape vertically from the end of the spinal column to the top of the shoulder at the base of the neck. Trunk length was recorded correct to the nearest half centimetre.\textsuperscript{9}

\textsuperscript{7}Ibid., p.49.

\textsuperscript{8}Ibid.

Arm Length

Arm length was measured from the acromion process above the shoulder joint to the tip of the middle finger. It was recorded to the nearest half centimetre.\textsuperscript{10}

Upperarm Length

The subject was asked to stand straight and relaxed. A steel tape supplied by Mollimex Company was used. The tip of tape was placed on the tip of acromion process and measured to the head of radius. This length was measured to the nearest half centimetre.\textsuperscript{11}

Forearm Length

Forearm length was calculated for each subject by subtracting the score of upperarm length from the scores of arm length.

Head Circumference

Head circumference was measured with a flexible steel tape placed round the head at the maximum circumference of the head. The subject sat comfortably on a

\textsuperscript{10}Cureton, \textit{Physical Fitness of Champion Athlete}, p.49.

\textsuperscript{11}Ibid.
chair. It was recorded correct to the nearest half centimetre.

\textbf{Shoulder Width}

The subject stood with his shoulder relaxed.
The inside edge of the fixed arm of the modified sliding calipers was kept resting on the outside edge of the acromial process of one shoulder blade and the moving arm of sliding calipers was brought inward until inside edge or the moving arm rested on outside edge of acromial process of the other shoulder blade. It was recorded correct to the nearest half centimetre.\textsuperscript{12}

\textbf{Upperarm Girth}

Upperarm girth was measured with a flexible steel tape, with the arm extended and hanging loosely at the side of the subject, placed around it half-way between the acromion process and the elbow joint. It was recorded correct to the nearest half centimetre.\textsuperscript{13}


Thigh Girth

Thigh girth was measured with a flexible steel tape placed round the thigh horizontally with its top edge just under the fold of the buttocks. The subject stood with his weight equally distributed on both feet. Thigh girth was recorded correct to the nearest half centimetre.\textsuperscript{14}

Calf Girth

Calf girth was taken with a flexible steel tape at the maximum circumference of the calf in a plane at right angle to its long axis. The leg was held dangling over a table top so the tape measures was in a horizontal plane. In this position, the calf muscle is quite relaxed. Calf girth was recorded correct to the nearest half centimetre.\textsuperscript{15}

Leg Length/Trunk Length

The ratio for each subject was calculated by dividing the score of leg length by the corresponding

\textsuperscript{14}Tanner, The Physique of the Olympic Athlete.

\textsuperscript{15}Ibid.
score of trunk length and value so obtained was recorded correct to two decimal digits.\textsuperscript{16}

**Foreleg Length/Thigh Length**

The ratio was computed by dividing the score of foreleg length by the corresponding score of thigh length and the obtained value was recorded correct to two decimal digits. This ratio is named to as Crural Index in literature.\textsuperscript{17}

**Forearm Length/Upperarm Length**

This ratio was calculated by dividing the score of forearm length by the corresponding score of upperarm length and the value so obtained was recorded correct to two decimal digits.

**Behavioural Variables**

**Level of Aspiration**

The Test:

A broad survey was made of various standard tests to measure level of aspiration, particularly of the middle

\textsuperscript{16} Cureton, *Physical Fitness of Champion Athletes*, p.49.

\textsuperscript{17} Ibid.
school students. After discussing with faculty members guiding research and experts in psychology, it was decided to use test prepared by H.M. Singh and G. Tiwari.\textsuperscript{18} This test is a standardised, valid, reliable and objective test that can be given inside a classroom, to single individual as well as in groups. This test has been widely used in psychological research in our country. A major choice of this test was because Singh and Tiwari have computed norms for Indian population after establishing its validity and reliability under Indian conditions.

Procedure:

The subjects were assembled in four batches of 25 each, in the sports psychology laboratory of the Lakshmibai National College of Physical Education, Gwalior. They were asked to sit comfortably and were advised to have peace of mind and free from outside disturbances. The investigator also persuaded the subjects to participate in the study and created a very congenial and friendly atmosphere before the test sheets were distributed to them. They were asked to write their name, age and

\textsuperscript{18}Singh and Tiwari, \textit{Manual for Level of Aspiration}. 
group number on the top of the test sheet in the space provided for this purpose. All necessary instructions were given regarding the test and their doubts, if any, were cleared by the researcher. On the test sheet there are 5 rows of 48 half inches squares. In first, third and fifth row, there are ten squares and in second and fourth row, there are nine squares. In total there are 48 squares. On the top left hand corner of the test sheet there is a space for the expected scores, and on the bottom right hand side there is space for actual scores. In the test the subjects are required to draw 6 lines making Swastika (صغر), as many as possible, within 30 seconds. Before the start of test, each time the subject is required to write his expected score in the space provided for this purpose and after the test the actual score is entered in the space on bottom right hand side.

After making sure that the subjects had understood the procedure clearly they were asked with a signal 'start' to draw Swastika starting from left to right side in each row within the prescribed time. On the expiry of 30 seconds they were asked to 'stop' and count the total number of Swastikas they have drawn and enter this
score in the space on bottom right hand side. This number gave them an idea for their goal setting for the next attempt. Then the subjects took a new test sheet and wrote the expected score for the second attempt. On the command 'start' they again repeated the test and in this manner the test was administered ten times.

Scoring:

The completed test sheets of each subject were first checked to make sure that each subject had completed the test ten times. The Discrepancy Scores (D-scores) of each subject were calculated with the help of following formula:

\[
D\text{-Score} = \text{Actual Score} - \text{Expected Score} \\
\text{(of the next trial).}
\]

(D-Score is the difference between actual score in a trial and the expected score of the next higher trial). The mean of the nine D-scores gave the level of aspiration of the subject, and was calculated with the following formula:

\[
\text{Level of Aspiration} = \frac{\text{Sum of D-Scores}}{9}
\]

The scores obtained in decimal digits were rounded up and were directly used for calculation purposes.
**Intelligence**

**The Test:**

A survey was made of different tests of intelligence for the middle school students and after a detailed discussion with faculty members teaching and guiding research in psychology, it was decided to use the verbal intelligence test prepared by R.K. Ojha and K. Ray Choudhury.\(^{19}\) This test is in Hindi version and it is a standardised, valid, reliable and objective test which is very widely used on educated adolescents. This test can be given inside a class-room, to single individual as well as in groups. A major choice of this test was because Ojha and Choudhury have computed norms for Indian population after establishing its validity and reliability under Indian conditions. The test consists of eight sections: classification, analogies, synonyms, number test, completion test, paragraph test, best reasons, and simple reasons. In all there are 112 questions with a time limit of 40 minutes.

**Procedure:**

The subjects were assembled in four batches of 25 each, in the sports psychology laboratory of

\(^{19}\) Ojha and Choudhury, *Verbal Intelligence Test*. 
Lakshmibai National College of Physical Education, Gwalior. The purpose of the test was explained to establish good rapport. Subjects were assured that the responses obtained on the test will be kept secret. The investigator persuaded the subjects to participate in the test whole heartedly and in a friendly atmosphere. The answer sheets were then distributed to the subjects and they were asked to write their name, age and group number on the answer sheets in the space provided for this purpose. All necessary instructions were given regarding the test and the doubts, if any, were cleared by the researcher. They were also given sufficient time to read the general instructions given on the main page. Then they were asked to turn to question number one and read the instructions, example and time limit carefully. Later they were given the signal to 'start' the first question and then 'stop' on the completion of prescribed time limit. Similarly all the eight sections were attempted.

Scoring:

There is a separate 'answer key' provided with the test and every question was marked by comparing with the answer key. Every correct answer was awarded one point.
Likewise the total 'award' obtained in all the eight sections were calculated for each student. Later the total award obtained by each student were converted into I.Q. scores by using the table provided in the manual.

**Concentration**

**The Test:**

The concentration ability of the subjects was measured by using Electrical Mirror Drawing Apparatus, supplied by National Psychological Corporation, Agra. This instrument is available in Sports Psychology Laboratory of Lakshmibai National College of Physical Education, Gwalior.

The diamentions of the electrical mirror drawing apparatus are 30 x 30 cms. in length and width. In the centre of the platform of the apparatus there is a steel plate which has a star in the centre of 11 x 11 cms. length and width respectively. A star of similar design but, 9 x 9 cms. in length and width is fitted in the centre of the bigger star in such a way that the space left between the outer edge of the steel plate star (bigger star) and the outer edge of the centre star
(smaller star) is one cm. all around the smaller star.

On the right corner of the platform a meter is fixed which records the number of errors made by the subjects while performing test. On the same side a red light is also fixed which indicates that error has been made by the subject. On the right front corner of the apparatus, a electric wire which is attached with thin iron rod covered from top with rubber and left naked from bottom, is provided. This is to be moved in the space left between the two stars. On the left front corner of the platform a plate, of fifteen cms. height and 20 x 20 cms. length and width, is fixed horizontally just on the top of the star which is fixed on the centre of the main platform of the apparatus. This is provided so that the star is not visible to the subject directly as the subject is supposed to move the thin iron nob in the space left between the two stars by looking into the mirror and not directly. A mirror of 23 cms. in length and 22 cms. in width is fixed vertically up at the back of the main platform. The apparatus is to be supplied electricity when it is to be used in order to record the number of errors committed by the subjects in each trial.
Procedure:

The concentration ability of the subjects was measured in sports psychology laboratory of Lakshmibai National College of Physical Education, Gwalior. A calm and quiet atmosphere, as required to conduct this test, was provided. Each subject was instructed to sit comfortably in the sports psychology laboratory and they were also requested for their whole-hearted co-operation in this study. The subject was asked to sit in front of the mirror drawing apparatus. The rubber pin having thin rod was given to the subject and was placed at the starting point in the star. The wooden plate was adjusted horizontally at adequate height above the hand of the subject so that star task was not directly visible to the subject. The subject was told to move the pin in such a manner so that it does not touch the outer parts of the smaller and bigger star and subject was also instructed to concentrate into the mirror while performing star task with his hand. For each trial total number of errors and total time taken to complete each trial was recorded and in similar way they were given ten trials and the average of total time and errors for each individual was calculated.
Before collecting the final data each subject was given three trials in order to make them familiar with the apparatus.

Scoring:

The total number of errors were those when the iron rod touched with either outerparts of the smaller and bigger star and this was recorded in the meter recording number of errors. The stop watch was started as the command was given to begin and stopped as the subject completed the star task. The total time taken to complete the task was recorded.

The average of ten trials was recorded in order to obtain highly reliable scores as ten trials in each case considered to be sufficient to yield reliable scores. The raw scores were converted into composite scores which were considered as individual score on concentration.

Physiological Variables

Percentage of Body Fat

Percentage of body fat was measured with the help of skinfold measurements. Skinfolds were recorded at four
sites of the body i.e. triceps, back, hip, and stomach. The four readings were summed and the total skinfold reading was converted into percent fat by using the regression equation of Yuhasz as follows:

\[ \% \text{ fat} = 5.783 + (0.153 \times \text{sum of 4 fat measures}) \]

Skinfold Measurements

Lange skinfold caliper was used to measure the skinfolds. The investigator picked up a fold of subcutaneous tissue firmly between the thumb and the index finger of the left hand and pulled out away from the underlying muscle at the marks marked on the body of the subject. The jaws of the caliper were then applied at right angles to the raised skinfold about 1 cm. from the point where the skinfold was lifted. It was allowed to exert full pressure before taking the reading of the thickness of the fold. The muscular tissue was not included in the pinch, was ensured by asking the subjects to use the muscle in appropriate movement. Measurements

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were taken on the right side of the body and were recorded to the nearest millimeter. The anatomical sites utilized were as follows:

1. **Triceps**: The measurement was taken over the triceps at a level half-way between the tip of acromion process and the tip of elbow (Olecranon process). Arm was hanging freely on the side. Skinfold was lifted on back of the right arm parallel to the long axis of the arm about 1 cm. above the site.

2. **Back (Subscapular)**: The skinfold was located 1 cm. below the inferior tip of the scapula with the subject in a relaxed standing position. The fold was lifted parallel to the long axis of the body.

3. **Hip (Supra-iliac)**: The skinfold was lifted on the right midaxillary line just above the crest of the ilium and to follow the natural diagonal line at this point.

4. **Stomach (Abdominal Skinfold)**: The skinfold was lifted about 1 cm. to the right of the umbilicus and parallel to the long axis of the body.
Body Density

To obtain body density of the subjects the percent body fat of each subject was compared to a ready reckoner prepared by Keys and Brozek\textsuperscript{22} and was recorded in cu./mm. upto four decimal digits.

Vital Capacity

Equipments:

Dry spirometer, alcohol, clean piece of cloth, nose clip.

Procedure:

Vital capacity was measured with a dry spirometer supplied by Hindustan Scientific Instrument Co., New Delhi, made in Germany, in litres and the subjects were tested in standing position. The inner dial of the spirometer was set on zero mark at the beginning of the test. The subjects took two deep breaths before starting the test and then after fullest inhalation the subjects placed the mouth piece of the spirometer in his mouth, taking care to see that no air escaped through the edges of the mouth piece. The subjects exhaled slowly and steadily

\textsuperscript{22}A. Keys and J. Brozek, "Body Fat in Adult Man," Physiological Review 33 (1953):245 cited by Ibid., p.44.
while bending forward slightly until the maximum volume of air could be expelled without taking in a second breath. The subjects were instructed to take care that they blew out only through the mouth and not through the nose even partially, however, the nose clips were used to prevent the air flow from escaping through the nose. Each subject was provided a trial before the final test. Three trials were given to each subject in the final test and the score was recorded in cubic centimetres.

**Scoring:**

Best effort of each subject, out of the three trials, was recorded as score of vital capacity in cubic centimetres.

**Aerobic Capacity**

To measure the aerobic capacity of the subjects Cooper's 12 Minute Run/Walk Test was used. For this test, the 400 M. track was marked into eight divisions of 50 metres each. The runner started behind a line upon the starting signal of run and/or walk as many laps as possible around the track within 12 minutes. The officials maintained a count of laps for each subject,
and when the signal to stop was given, the subject stopped and the officials immediately ran to the place at which their respective runners had stopped. The score in metres was determined by multiplying the number of completed laps with the distance of each lap plus the distance of number of segments of an incomplete lap.23

**Power (Explosive Strength of the Legs)**

Sargent Jump24 was used to assess explosive power of the legs. The subjects were assembled in batches and appraised of the objectives of the test and the test was fully described. A black board was fixed on the wall which was marked in segments of two centimetres each starting from 1.20 metres above the ground. In this jump, the individual swings his arm downward and backward taking a crouch position with knees bent approximately to a right angle. The subject pauses in this position to eliminate the possibility of a double jump and leaps upward as high as possible, swinging the arms forcefully

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forward and upward. As the subject reaches the highest point of the jump he swings the arm forward and downward, motion being timed to coincide with height of the jump. The specified movements in executing the jump are extremely important. The subjects were asked to stand close to the wall and touch the board with fully stretched hand and the reading was recorded. He then put chalk powder on finger tips and tried a jump. As he jumped and touched the black board, the powder left a mark on the board and this reading too was recorded. Similarly three trials were given to each subject. The difference between the initial reading (standing) and final reading (jump) of the best jump was calculated and this was considered the score of vertical jump.

Scoring:

Best of three trials was recorded to the nearest segment of two centimetres as score of power.

Arm and Shoulder Strength

To measure the arm and shoulder strength of the subjects pull up test was administered on the metal horizontal bar of three centimetres diameter fixed at
a convenient height so that subject's feet did not touch
the floor while he was hanging with arms straight.
From this hanging position, the subject pulled himself
up until the chin was above the bar and lowered himself
until his arms were fully extended. The subject was
instructed to avoid kicking and jerking movements.
Maximum number of correctly executed pull ups was consi-
dered as subject's score.25

Abdomen Strength

For measuring the abdominal strength of the
subjects Bent Knee Sit Ups were used. From a lying
position on the back, the subject flexed his knees
over the yardstick while sliding his heels closer to the
seat. The yardstick should be held tightly under the
knees until the subject was instructed to slowly slide
his feet forward. At the point where the yardstick
dropped on the mat, the tester would mark the heel line
and seat line in order to indicate how far the feet should
remain from the seat during the bent knee sit ups exercise.
The fingers of the subjects should be inter locked behind

the neck and perform sit ups alternating a left elbow touch of the inside right knee and a right elbow touch of the inside left knee. The movement was performed as many times as possible.

The total number of repetitions were recorded as scores of the subject. However, repetitions were not counted when finger tips did not maintain contact behind the head, when the knees were not touched, or when the subject pushed-off the floor with the elbow.\textsuperscript{26}

\textbf{Leg Strength}

The leg strength of the subjects was measured by administering the leg lift on leg dynamometer with the belt. The leg dynamometer was available in the Human Performance Laboratory of the Lakshmibai National College of Physical Education, Gwalior. The subject stood with his feet in the proper position on the base of the dynamometer knees slightly bent, and held the bar with both hands together in the centre, both palms down so that it rested at the junction of thighs and trunk. Care was taken to maintain this position during the lift also. The belt then was tied tightly around the back and the bar, closer to the hips and gluteal muscles.

\textsuperscript{26}Ibid., p.120.
Then the subject was instructed to lift steadily. The investigator ensured that the arms and back were straight, the head erect and the chest up during the lift. Three trials were given to each subject with adequate rest in between. The best of the three trials was recorded as score of leg strength in kilograms.\textsuperscript{27}

**Average Ankle Flexibility**

**Equipment:**

Goniometer.

**Procedure:**

Average flexibility of the right and left ankles was measured with the help of a goniometer consisting of a 180 degree protractor with two extended arms of 15 inches length; the one at the zero line is fixed, the other movable. The fixed arm of the goniometer was placed parallel with the lower leg, with the centre of motion at the ankle joint. Readings were taken with the ankle dorsi flexed as fully as possible, and again with as full planter flexed as possible.

Scoring:

The difference between the two readings (dorsi and planter flexion positions) represented the range of motion in degrees and right and left ankles were averaged. 28

**Trunk-Hip Flexibility**

**Equipment:**

Platform scale, two gymnasium (stall-bar) benches and a mat.

**Procedure:**

To measure the trunk-hip flexibility the Wells and Dillon Sit and Reach Test was administered on the subjects. The subject sat on the mat with feet placed in the footprints and pressed firmly against the cross board. The arms were extended forward with the hands placed palms down on the upper surface of the scale. In this position, the subject bent forward four times and held the position of maximum reach on the fourth count. The knees remained straight. If the hands reached unevenly, the hand reaching the shorter distance determined the score.

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Scoring:

The maximum distance reached, taken to the nearest centimetre, was recorded as the score of trunk and hip flexibility.\(^{29}\)

**Shoulder Flexibility**

**Equipments:**

A measuring stick, and a small round wooden rod 24 inches in length.

**Procedure:**

The subject assumed a prone position on a flat surface, the chin touching the floor, and the arms extended forward shoulder-width apart. The rod is grasped and the elbows and wrists kept straight. Then the rod is raised upward from the floor to the maximum height possible along the erect kept measuring stick.

**Scoring:**

The height raised from the floor to the underside of the raised rod, measured to the nearest centimetre,

\(^{29}\) Ibid., p.122.
was recorded as the score of shoulder flexibility.\textsuperscript{30}

**Dependent Variable**

**Organisation of Swimming Teaching Classes**

For the purpose of teaching swimming the subjects were divided into 4 teaching groups of 25 boys each, with the help of a table of random numbers, to facilitate better control and conduct of the classes. The swimming teaching classes were conducted in the morning from 6.00 to 10.00 AM. The instructions were imparted by the researcher, who is a well qualified and experienced swimming coach, with the help of four other qualified swimming teachers appointed by the Lakshmibai National College of Physical Education, Gwalior for their Summer Swimming Programme. The experimental groups met 5 times a week for the purpose of instructions in crawl stroke, with each period of 50 minutes duration, for a period of 10 weeks. Instructions in swimming were standardised and daily schedule of lesson plans were made in advance and strictly followed to control the quantum to be same

for all the subjects. Individual guidance to any of the subjects was avoided and all clues, comments, and directions were given to the whole class whenever required.

Proper and sufficient practice on drills was given in order for effective learning of the technique. The teaching was done from simple to complex skills. In the first two weeks much emphasis was given on the water fear removing drills like, entering the water, walking on the shallow end, submerging, seeing under water, rhythmic breathing, floating and gliding. The stroke was later introduced. It was sub-divided and developed into sequence like body position, leg kick, arm pull, lateral breathing and the combined full stroke in order that the parts were well learned.\textsuperscript{31} Visual impressions of the desired movements were given by demonstrating the correct skill and showing sequential illustrations with the help of wall charts.\textsuperscript{32} No teaching and floating.


devices were used in order to eliminate the chances of any aid in learning swimming. All subjects were also asked not to practice swimming outside the class during the course of the experiment. Their special cooperation was asked with respect to absences, although some absences did occur, but none exceeded 4 in number.

The quantitative learning of crawl stroke swimming was determined by calculating a sum of the composite scores obtained from the speed of swimming front crawl stroke and the technique of the standard crawl stroke. The testing in both 50 metres swimming performance and the subjective skill rating was done on the expiry of 10 weeks teaching programme.

50 Metres Swimming Performance

The subjects were asked to swim as fast as possible for a distance of 50 metres with a push-off from the wall on the starting signal. Three timekeepers were assigned for each swimmer and along with the starting signal the

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timekeepers switched on their watches and took the time for 50 metres. Three subjects were made to swim at a time to provide competitive environment. The official timing, as per existing swimming rules, was recorded in seconds up to one decimal digit.

**Subjective Skill Rating**

Skill rating was done by the subjective judgement of five qualified swimming coaches who used a 10-point scale \(^{34}\) and followed the standard rules of the crawl stroke technique. The subjects were asked to swim, one at a time, at a moderate speed over a distance of 25 metres. In judging the technique, each judge considered the stroke rhythm, the relaxation, the power, length of the arm pull, lateral breathing technique, arm recovery, depth and the technique of leg kick. \(^{35}\) The scale used is as follows:

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Very Good  -  8½ to 10 points  
Good       -  6½ to 8 points   
Satisfactory -  4½ to 6 points 
Deficient  -  2½ to 4 points  
Unsatisfactory  -  0 to 2 points

The highest and lowest awards were cancelled and the average of the remaining three awards was calculated up to two decimal digits and taken as the score of skill learning of each subject.

**Analysis of Data**

The relationship between dependent variable (swimming learning scores) and each of the independent variables (anthropometric, behavioural and physiological factors) was established by computing Pearson's Product Moment Correlation (Zero order) and separate Correlation Matrices for each category were prepared. The combined effect or contribution of anthropometric and physiological variables on swimming learning was obtained by computing Multiple Correlation separately for these two categories. Multiple correlation was also computed to assess a
combined effect of all the anthropometric, behavioural and physiological variables, taken collectively, on swimming learning.

To identify the most contributing independent variables to crawl stroke swimming, Step Down regression method was used. In order to predict the swimming learning ability on the basis of most contributing anthropometric, physiological, and all variables combined, Regression Equations were developed.

For testing the hypothesis the level of confidence was set at .05.