A RELATIONSHIP BETWEEN GENERAL MOTOR ABILITY AND OBJECTIVE MEASURES OF ACHIEVEMENT IN SWIMMING AT THE INTERMEDIATE LEVEL FOR COLLEGE WOMEN

by

Marcia Ruth Wilson

A Thesis Submitted to
the Faculty of the Graduate School at
The Woman's College of the University of North Carolina
in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Physical Education

Greensboro
June, 1962

Approved by

Rosemary McGee
Director

APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at the Woman's College of the University of North Carolina, Greensboro, North Carolina.

Rosemary McGee
Thesis Director

Oral Examination
Committee Members

Ethel Martin

Dorothy Davis

Laura G. Anderton

July 5, 1962
Date of Examination

Title

89. A Relationship between general motor ability and objective measures of achievement in swimming at the intermediate level for college women

Author

MARCIA RUTH WILSON

Vol. & Date

Call No.

Color 2571

Special Instructions:

'S

sincere gratitude to Dr.

, and inspiration during

s Margaret Kingston for her

: and to the seventy inter-

his study a realization.

he receipt of the Hazel

National Aquatic Forum.

as gratifying.

ACKNOWLEDGEMENTS

The writer wishes to express her sincere gratitude to Dr. Rosemary McGee for her interest, efforts, and inspiration during this study.

Special thanks is extended to Miss Margaret Kingston for her interest and cooperation as an instructor and to the seventy intermediate swimmers whose enthusiasm made this study a realization.

The writer wishes to acknowledge the receipt of the Hazel Wilbraham Research Grant from the Women's National Aquatic Forum. This evidence of support and confidence was gratifying.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Swimming often seems to be placed in a category separate from other sports. Yet it has many common elements which affect skill or proficiency: coordination, balance, kinesthetic sense, rhythm, flexibility, power, and strength. The one basic difference is the medium in which this activity is performed; that is, water. This condition adds more components to the list; resistance, relaxation, breathing, buoyancy, and fear now play important roles. Then even those elements common to land activities may assume a new dimension.

Scott devised a General Motor Ability Test in which she defined this ability as an "innate capacity or potential for acquiring skill." (13:63) Her criteria for validation included careful observation and rating of the performers' skills in selected activities. Therefore, a score on this test may be used as an indication of the skill achievement an individual may attain. This leads to the question of whether or not this same General Motor Ability score is indicative of performance in the water. If the swimmer is motivated, will this score predict her achievement, and is this relationship the same in swimming as in land sports? Is the test a measure of motor ability in the water, or do these common elements assume an entirely different role when the body is submerged in water?

With these questions in mind, this study was originated in an attempt to establish the relationship between General Motor Ability and

achievement in swimming. The investigation was geared to women on the college level. The intermediate swimming level was chosen for study in an attempt to minimize such variables as fear and inconsistency of performance which are present in greater proportions at the beginning level. Herein an intermediate swimmer is defined as one who is at ease in deep water and can swim twenty-five yards.

A further purpose of this study was to establish an objective measure of swimming ability at the intermediate level. The area of swimming seems to lack objective tests. There were none available which could be used for this study. A test battery, as well as judges' ratings, on important intermediate skills could then be used to measure swimming achievement over a period of time. Scores on an objective test battery could also be used by the administrator to classify students for various levels of swimming instruction. The teacher could use it as an evaluation instrument.

Thus there are two purposes to this study: (1) to determine a relationship between General Motor Ability and achievement in intermediate swimming, and (2) to establish objective measurement indices for intermediate swimming.

CHAPTER II

REVIEW OF LITERATURE

Current research can provide for scientific application of results to the educational process. A teacher must first of all be concerned with understanding the individual, but utilization of knowledge gained in research and through testing can add significance to her efforts. The instructor should be analytical of abilities and related factors to continually challenge and interest the learner. (14) In her introduction to the General Motor Ability test, Scott emphasized that "Prevalence of achievement forms indicate that much evaluation of student ability is in terms of absolute accomplishment rather than potentialities of accomplishment." (13:64) Consequently, many studies have been conducted using various combinations of the Scott General Motor Ability battery. This test was constructed on the premise that a knowledge of "the innate capacity or potential for acquiring skills" (13:63) is desirable for successful teaching. These studies have been concerned with a gamut of applications and relationships, each pertaining to factors of skill performance which may or may not be parallel in activities performed on land and in the water.

SWIMMING ABILITY AND ACHIEVEMENT

Gross motor skills and refined movement patterns become more complex when executed in the water. To coordination, balance, kinesthetic sense, rhythm, flexibility, power, and strength are added the factors of

resistance, relaxation, breathing, and buoyancy. It seems that these latter components either create a more intricate design or modify those already present.

In considering the implications of movement in water, Torney chose seven fundamental principles which he felt pertained to skill performance in swimming:

1. The secret of effortless swimming lies in the relaxation of muscles not necessary to the performance of the skill at any given moment.
2. The breathing rhythm of swimming differs from the rhythm of normal breathing.
3. The position of the glide is one of rest.
4. The recovery of the arms and legs should be performed slowly and in a relaxed manner.
5. Each countermotion, against the forward movement, should be so performed that a minimum of resistance results.
6. There should be a minimum of overwater recovery, excepting when the desire or need for speed justifies the extra expenditure of effort.
7. The body, in smooth water and when ease rather than speed is the desire, should be maintained in a position as flat and as parallel to the surface as possible. (8:102-3)

Torney (8) added several explanations for his choices. He felt that the expert swimmer's technique is based upon complete relaxation. In swimming this is created through selection and discrimination. He stated that there is a pause after inspiration but not after expiration in rhythmic breathing. This is for buoyancy. The glide provides for the use of momentum gained from the power phase. This resting time aids endurance. Effort should be expended only during the power phase. He emphasized that each lift above the water must be counteracted by exertion

against the sinking effect which the added weight has upon the rest of the body.

Swimming differs from walking, running, and other movements in that the surface against which the force is applied for forward motion is not as resistive as the usual hard walking surface. Yet walking requires movement through air, a soft surface, which offers little resistance in comparison to water. The water offers a great deal more resistance but affords a soft surface against which the body applies its force. The effect of the force of gravity is minimized due to the density of the water. The density of air makes progress much faster, while water requires more effort and progress is slower. Minimizing the resistance of the water in the direction of desired movement is important. This can be accomplished by assuming a stretched position, and by relaxing to minimize weight. This streamlined body position, with the use of both the arms and legs, increases the force potential.

Since the water is the medium which supplies the resistance to move the swimmer, another concern is increasing the force in a direction opposite to that in which movement is desired. Thus a good swimming pattern is enhanced by minimizing the resistance of the water to movement in the direction of progress and increasing the resistance in the opposite direction. (1)

Cureton (3), who did extensive research in the area of swimming, defined five factors which are involved in balance and body control in the water. First, the sense of balance, which is governed by the semicircular canal mechanism of the body, is a receptor to the swimmer although

it may be modified by natural buoyancy. Second, the kinesthetic sense of position is an indicator of the relative position of the body in the water and of its parts with one another. Third, unique to swimming are the pressure sensations of water upon the body. The delicate perception they afford can bring a more refined skill. Fourth, the anatomical structure calls into play a set of factors which is different from those of most sports. Here the natural buoyancy of the body will dictate to some extent the amount of work required to propel the body through the water. The weight of various parts of the body in the water will also determine the position which the body assumes during relaxation. The fifth factor is the balancing movements of the head, arms, and legs. (3) Included in this is the degree of relaxation attained. Body position is partially dependent upon normal body balance which in turn is dependent to some extent upon the degree of relaxation present.

Fear is commonly recognized as a barrier which must be overcome by each swimmer. The degree of fear and the time required to surmount it varies, but it has a great influence upon the progress of a swimmer. Each swimmer may sense fear differently when placed in this new media. The movements of the water cause varying pressures upon the body which have not been experienced elsewhere. Movement in swimming is accomplished by propelling in a horizontal position. The vertical position is more common to land movements. The simultaneous freedom of every body part during movement removes the security of any stationary surface. The swimmer must rely entirely upon herself and her body. Perhaps this is movement in the truest sense.

After considering every possible factor, the final outcome is left to the individual—her perception and her understanding.

> In general, the patterns of skillful swimming performance have become fairly well established and standardized. However, given standardization in every swimming skill pattern, the last word on good technique will still be one of search by each individual swimmer. He comes to know the right answer for himself, through the functioning of his kinesthetic sense.
>
> What is the kinesthetic sense? It is the sense which, in any sort of motor activity, gives awareness of every movement and position of the body. It is one's natural checking equipment for measuring the degree of accomplishment or fulfillment of his purposes.
>
> So it is, that the joys of swimming with ease and grace, with good technique, become inner joys, ... The books and teachers must remain only voices of experience and guides, but not the last word, because for every swimmer the final check on the fulfillment of good technique is within himself. (6:44)

Among the books written for swimming and aquatics, Torney (8) mentioned the variables surrounding each individual which affect achievement. Some may learn faster through what they see, others through understanding or reasoning. They might feel the need to verbalize the movement they wish to perform. "Individuals also vary in the amounts of motor ability they possess, in their responses to different types of motivation, and in natural buoyancy." (8:693)

Most important of all, Torney stressed the multitude of influences which are impossible to measure but which manifest themselves in the educational process. Some are specifically for swimming but motivation, insight, and understanding should always be present for any successful learning situation. This points to the teacher's importance in any learning situation and in particular her knowledge of each individual and of the intricacies of the skill she is teaching.

Berg cautions against completely neglecting the individual as a person and being concerned only with teaching a skill. "... we begin to lose the human touch in our very devotion to method and skill." (9:258) The dynamics of the whole process of learning to swim are much more than just developing technique. They involve an integration of the person--a total neuromuscular reeducation--a perception or awareness of being able to swim.

> In the acquisition of any skill in which muscular coordination is a major factor, this role of the complete organism must be remembered and acted upon if efficient learning is to occur. The acquisition of skill in swimming shows this to perfection. The upright posture of man is apparently the prime reason why swimming is not a native or unlearned skill for him as it seems to be for most quadrupeds. Most other land animals make an immediate adjustment...upon being thrown into the water, helped, no doubt, by the fact that their posture can be kept much the same as in normal locomotion. In man the mastery of the necessary motor controls in swimming is like a delayed perceptual insight where the figure is hidden in the 'ground,' for it takes some time to grasp the 'pattern' of the swimming performance and to translate this into the appropriate sequence of movements. It is not enough, as everyone knows who recalls his own first efforts to swim, to breathe correctly, to hold the head and body in the right position, to kick properly, and to swing the arms in the desired fashion, if all these things are done without reference one to the other. These things must all be assembled into a working unit before the skill of swimming as a configured action really exists. The integration of these partial responses into a higher-order act which depends upon each of them but which none of them alone can bring about is the descriptive essence of every skill known to man. (6:198)

MOTOR ABILITY

A limited number of studies have been conducted concerning a relationship between motor ability and swimming. In several instances a relationship was established but with many qualifications since the relationship was not the main emphasis of the studies.

While she acknowledges that there are many complex and perhaps many unknown factors, Scott (14) found some indication of a relationship between the learning rate of beginning swimmers and General Motor Ability. Five judges rated twenty beginning swimmers after they had completed twelve to seventeen lessons and passed a fifteen minute endurance test. Form and safety were judged on a five-point scale. Form ratings included the back stroke, the side stroke, and treading water. Criteria under safety were relaxation, ease, and confidence in deep water. The sum of the judges' ratings correlated with motor ability scores yielded a coefficient of .52 which was significant at the two per cent level of confidence.

Sollender (20) found no relationship between Scott's General Motor Ability Test and rate of learning to tread water. Beginners in a basic skills class were taught treading for twelve minutes of class time during ten lessons. Success was judged by the ability to tread for two minutes. A correlation of motor ability scores and speed in learning to tread water yielded a coefficient of -.06.

Several studies using the Brace Motor Ability Test revealed low correlations between learning rate and achievement. McNeely (18) used a battery of ten items to measure learning rates. A score consisted of the number of trials necessary to perform each in fair form. The mean of the T-scores of these ten learning scores was correlated with the Brace Motor Ability Test. She considered a coefficient of .322 to indicate a fair degree of correlation. A lower coefficient of .270 was found when using the Iowa Revision of the Brace Test.

Deach (16) used two motor ability test batteries. She defined Brace's as testing native rather than acquired traits and Alden's as testing factors having to do with acquisition of skills such as speed, strength, endurance, balance, accuracy, agility, control, and rhythm. Two hundred sixty-eight women registered in swimming classes were given achievement tests and classified as elementary, intermediate, and advanced swimmers. Students advanced as instructors passed them. The learning rate score used for the correlations was the sum of the number of days required to pass each swimming achievement test. The low correlations of both motor ability tests led her to conclude that either swimming does not depend upon general motor ability or the scales are not measures of such. She accepted the second as the most probable reason.

Rogers (19) chose to measure rhythm, motor ability, fear, and swimming achievement among eight beginning swimmers and to determine a relationship between each. Brace's test indicated little or no relationship with achievement. Her testing consisted of a checklist with items arranged in ascending degree of difficulty. She felt one of the major limitations was the need for tests of greater precision and higher validity.

Kuhl (17) divided seventy-four beginning swimmers into quartiles according to their scores on the Iowa Revision of the Brace Test. She found no adequate basis for assuming a significant difference in achievement between the quartiles when using a thirty-item battery.

EVALUATION IN SWIMMING

Formal evaluation in swimming has been limited, as in many skill areas, by the small number of possible tests which have been devised. Often the teacher uses her judgment as a measure, and this may be a valid one for her purposes. A rating scale on form may be satisfactory. A checklist indicating pass or fail may be used when the degree of excellence does not need to be determined. Or a checklist resulting in one final rating may be another possibility. More exacting and definite standards are needed for research if meaningful conclusions are to be reached.

Cureton (4) recognized a need for formulating a broad pattern for testing and did a series of comprehensive studies in an attempt to devise batteries and achievement scales representing major categories of skill. His studies were based upon the results of a questionnaire directed to eighty-five selected swimming teachers depicting preferred patterns for testing, the most valuable items to teach, and the desirable standards of performance. Dealing directly with the beginning level of swimming, he organized a refined battery of twenty-five graduated items and the performance standards for each. Skills were classified into seven major groups according to the emphasis in instruction. After administering the first experimental battery, he established reliability, validity, difficulty ratings, and scoring procedures based upon the number of items passed. The Multiple Regression technique was used to find the percentage contribution of each group to the total score criterion. A listing of the seven groups and the percentage contribution of each follow:

I.	Introductory Confidence and Adjustment Skills	11.02
II.	Breathing and Floating	0
III.	Body Control, Gliding, and Initial Safety Drills	3.28
IV.	Initial Diving Skills	61.81
V.	Leg Movements used with Regular Strokes	4.22
VI.	Arm Movements used with Regular Strokes	14.28
VII.	Coordination Items Involving Combination of the Parts into Composite Performances (10:54)	5.39

The Split-Halves method yielded a reliability coefficient of .95 for all twenty-five items. The twenty-fifth item, a combination of beginning skills, was used as a criterion to establish the validity of each group by Tetrachloric Correlation. The highest coefficients (.95 to .72) included the coordination skills involving actual swimming. Next highest (.68 to .61) were those involving a glide: underwater swimming, diving, and flutter kicking. Submerged activities such as diving and underwater swimming yielded coefficients from .62 to .58.

Several items were eliminated after the initial test due to their difficulty and were classed as intermediate skills. They included the following skills:

1. Sculling vertically (treading)
2. Underwater push and glide below the surface
3. Standing plunge dive
4. Progressive bobbing in deep water

Cureton developed progressive tests for the National Y. M. C. A. and stated that "Intermediate swimming seeks to develop a variety of

skills toward all-around performance in five categories." (2:17) These categories were the bases for establishing the tests:

I. Basic Skills, including front crawl, back crawl, breast stroke, and side stroke

II. Body Control and Sculling Stunts

III. Life Saving Prerequisites

IV. Endurance Swims

V. Introductory Dives
(2:17)

His scale contained twenty-five items which included the following skills:

1. Treading
2. Surface dive
3. Swim underwater
4. Front crawl, start and turn
5. Side stroke
6. Back crawl, start and turn
7. Plunge dive
8. Breast stroke, start and turn
9. Seal turns
10. Crab sculling

Hewitt (12) established swimming achievement scale scores after testing 1,093 students at six high schools in the San Francisco area. Reliability coefficients, based upon two administrations, ranged from .89 to .96. Validity coefficients, as determined by correlating each event with the whole score, ranged from .604 to .94. The side stroke (.94) provided the best single measure with the criterion. A list of these six

items, their reliability, and their validity, follows.

	Reliability	Validity
1. Time in tenth of seconds 25 yard flutter kick	.89	.604
2. Time in tenth of seconds 50 yard front crawl	.92	.65
3. Minimum number of strokes 25 yard elementary back stroke	.96	.88
4. Minimum number of strokes 25 yard side stroke	.90	.94
5. Minimum number of strokes 25 yard breast stroke	.93	.77
6. Number of yards ten minute endurance swim		

The sixth item was eliminated for the second administration due to the excessive amount of time required.

Fox constructed a "Swimming Power Test" (11) which was an objective test for strokes. The distance covered in six strokes was measured from a rope suspended and dropped for a dead start. One experienced judge rated each swimmer for form. These ratings were correlated with the power scores and yielded a coefficient of .83 for the side stroke and .69 for the front crawl. The reliability coefficients were .97 and .95, respectively. She also recommended this successful way of measuring power for the back crawl, breast stroke, and elementary back stroke.

Smith (7) developed a comprehensive graded achievement chart for instructional purposes which included forty-two items for the intermediate level. It listed the back crawl, front crawl, inverted breast stroke, breast stroke, side stroke on both sides, and a series of dives from a standing dive to the back dive.

Skills considered essential for successful swimming, in addition to the strokes, were discussed by Torney. (8) Treading water calls for body control in a perpendicular plane. He felt that dexterity with the hands in finning and sculling, like breathing, should always be emphasized because they can adapt movements to any body position, for changing direction, changing position, regaining the surface, and stunts such as somersaults. He stated that the surface dive and underwater swim help to develop general watermanship, swimming technique, and forced breathing.

He further stressed the values and the perils of testing. The character of a test depends upon its purpose.

> Measurement is a sharp-edged tool. Depending upon the manner of its use, it may aid or hamper a work that is being done. Haphazard testing is a serious mistake; measurement is of value only if it is made in a purposeful and judicious manner. (8:182)

Torney stated that a classification test should require a minimum amount of time and recording, have the least number of items possible, be simple to explain and easy to understand, yet provide for the correct ability placement. He emphasized that tests designed to establish performance levels should include isolated factors in so far as possible.

The most comprehensive testing in swimming has been in the beginning area. The intermediate level has been neglected except for a few items or batteries which contain the various strokes. Cureton did give some attention specifically to the intermediate level. Batteries containing a variety of swimming skills are limited in number. Those available have included subjective measures such as checklists and ratings. The only objective measures have been those which measure the power of a stroke

or the number of strokes required to cover a certain distance. In the field of swimming, there seems to be a lack of objective measures, of comprehensive batteries, and of tests beyond the beginning level.

CHAPTER III

PROCEDURE

The two purposes of this study were: (1) to determine a relationship between General Motor Ability and achievement in intermediate swimming, and (2) to establish objective measurement indices in intermediate swimming.

Four classes in intermediate swimming were organized. A program was planned which included the administration of tests in order to fulfill the purposes of this study. Three tests were used. Each is discussed in detail in this chapter. The two swimming tests consisted of an Objective Test and a Subjective Test. The Objective Test was devised by the writer and was utilized to fulfill the two purposes of this study. The Subjective Test was formulated to validate the Objective Test. It included nine items with a rating scale for each. The Scott General Motor Ability Test (13) was selected to measure motor ability.

SELECTION OF SUBJECTS

The subjects for this study were college women who enrolled in four intermediate swimming classes for the spring semester of the 1961-1962 academic year at The Woman's College of the University of North Carolina. As a prerequisite for enrolling, the girls had to be able to jump into deep water, level off, and swim twenty-five yards. A total of eighty-four girls registered. Only seventy were included in the study due to medical restrictions and absences.

PROGRAM OUTLINE

The four intermediate swimming classes were taught by the writer and one other member of the Department of Physical Education. Each taught two classes. These classes met twice a week for a forty minute lesson each time. A total of twenty-five lessons were conducted during the period of this study. Spring vacation, which consisted of one week between the twenty-first and twenty-second lessons, was the only interruption in the weekly schedule.

The twenty-five lesson plans were formulated after the two instructors discussed their objectives and methods. Subsequently the instructors conferred weekly concerning the progress of each class and made any revisions necessary to allow enough time for thorough coverage of each skill and at the same time to keep the instruction in the classes as parallel as possible. Emphasis was placed upon practicing beginning skills, learning new skills, and building endurance. The final lesson plans appear in the Appendix.

The procedure during the course itself was initiated the first day of classes with a thorough explanation to the girls of the purposes of this study, how they would be involved, and the amount of time required of them. With the purposes of the study in mind the Objective Test and the Subjective Test were both administered at the beginning and the end of the lesson series. Before and during the initial testing period the girls were assured that they were not expected to be able to execute all of the items. Special emphasis was given to this point to keep them from becoming discouraged when attempting those items with which they were unfamiliar. The first lesson in the water was planned

to acquaint the swimmers with the test items so that the skills would not be entirely new.

OBJECTIVE TEST

Selection of Items

The final selection of items was based upon the results of a survey conducted by Cureton. (4) He established seven representative skill groups for the beginning level:

I. Introductory Confidence and Adjustment Skills
II. Breathing and Floating
III. Body Control, Gliding, and Initial Safety Drills
IV. Initial Diving Skills
V. Leg Movements used with Regular Strokes
VI. Arm Movements used with Regular Strokes
VII. Coordination Items Involving Combination of the Parts into Composite Performances (10:54)

After a preliminary test he eliminated several items from these groups which he considered to be intermediate. In another series he listed five categories chosen specifically for the intermediate level:

I. Basic Skills, including front crawl, back crawl, breast stroke, and side stroke
II. Body Control and Sculling Stunts
III. Life Saving Prerequisites
IV. Endurance Swims
V. Introductory Dives (2:17)

Other support for final test item selection was lent by Hewitt (12) with his achievement scale scores and Fox (11) with her power test.

Six items were ultimately chosen for the objective battery. They included skills representative of six of the seven groups in the beginning area suggested by Cureton. Some were similar to the skills he eliminated from this group because he felt they should be classed as intermediate skills. The six items also represented the five groups which Cureton

selected for the intermediate area.

A total of ten to twelve items which represented important skills was considered for the objective battery. Many of the items were eliminated because they were impractical for administration such as picking up rings plotted on the bottom of the pool. Some required an excessive amount of time. Others could not be measured accurately such as breathing while bobbing in deep water. A few were similar to the items selected.

The final six items were chosen in an endeavor to find items representative of a variety of swimming skills which a beginning intermediate could attempt and then perfect with practice. They also included integrated movements which are frequently utilized in swimming. Each in turn yielded a measure which was free from personal judgment and which approximated the skill itself. Each item had a definite numerical score.

1. Time: 25 yard flutter kick with kickboard
2. Time: 25 yard sculling, no leg kick
3. Number of strokes: 25 yard side stroke
4. Number of breaths: drownproofing
5. Distance in feet: Plunge dive and glide
6. Number of turns: Underwater swim

1. Flutter Kick

The flutter kick was chosen as the leg kick because speed and power are desirable. Timing this kick for speed would not tend to cause the swimmer to eliminate a glide. This would be more likely to happen in other kicks. Teachers usually consider it the initial kick to be

taught so that students enrolling in an intermediate class should be able to attempt it.

2. Sculling

Sculling was selected as the arm movement since it called for dexterity of the hands as well as for body control. It required a streamlined position and a smooth glide which offers little resistance. Again, timing a specified distance required speed and power, which are desirable. If the swimmer reverted to a type of finning she was automatically penalized because finning is not as efficient or powerful.

3. Side Stroke

The side stroke, selected as the coordinated skill, presented a stroke with a definite glide. It is a popular intermediate skill and a stroke necessary for life saving technique. Both Hewitt (12) and Fox (11) found an excellent validity correlation between their judges' ratings on the side stroke and their tests. The elementary back stroke is a beginning skill and the breast stroke is more complicated for the beginning intermediate to attempt without considerable practice.

4. Drownproofing

This method of survival swimming in deep water introduced several important components: breathing, relaxation, and a safety skill. The swimmer rested in a prone position using rhythmical breathing to perform drownproofing. It was specified that she should exhale constantly when her face was in the water. The score on the test consisted of the number of breaths required for the duration of one minute. The lowest score was

the most desirable. This item was considered a measure of the swimmer's ability to control her breathing.

5. Plunge Dive

The plunge dive for distance represented one of the more difficult phases of swimming. It called for proper direction and timing with force. No arm pulls or leg kicks were allowed on the glide. This was one of the items which Cureton dropped from his beginning battery and included in the intermediate one since it seemed more suited for that level.

6. Underwater Swim

The underwater swim consisted of following an underwater course laid out in water graduating in depth from four feet to seven feet. Six bricks were placed in a zig-zag course within two five-foot lanes. The object was to swim underwater and to turn, one-quarter turn, as many bricks as possible with one breath and in their numbered order. A diagram of the underwater course appears in the Appendix. This skill was chosen for the body control and endurance groups. It also represented coordination and breath control. Torney (8) stressed that proficiency in underwater swimming meets the need of feeling at home and secure under the water as well as on top. The graduated depth increased the difficulty of the test. Turning each numbered brick in order required more skill.

Administration of the Objective Test

Every effort was made to minimize the time required for testing and the number of testers necessary for efficient administration. The

objective test required only the instructor who could administer and record the battery for a group of twenty students in one class period. The procedure called for the girls to work in partners for the first four items. Each student scored for her partner. The score was then reported to the instructor. On the last two items the instructor scored the swimmer by observing from the side of the pool.

1. Flutter Kick

To prevent the swimmer from gaining momentum with a push from the side of the pool, her partner knelt on the deck of the pool and grasped the swimmer's ankles as she was poised in the water in a prone position with the kickboard. The partner held her feet just under the surface, with her pointed toes brushing the side of the pool. Her feet were released on the signal "Ready, Go!" The partner walked down to the opposite end while the swimmer traveled at her top speed the length of the pool performing the flutter kick. The instructor counted each second aloud as the swimmers neared the end. The partner on the edge watched her partner in the water and listened to the count to determine the second on which the kickboard touched the edge of the pool. When all had touched the end of the pool the instructor quit counting and recorded each girl's score as reported.

Each timing accommodated a minimum of one swimmer per lane. After half of the group swam to the opposite end, the partners took their turns.

2. Sculling

The same procedure used for the flutter kick was used for sculling. The starting position was on the back with the partner again holding the

ankles. The swimmer was instructed not to kick her legs in any manner. To mark the finish the partner placed the back of her hand against the side of the pool with her palm open. She recorded the second upon which the swimmer's head touched her hand.

3. Side Stroke

The object of the side stroke was to take the least number of strokes possible for one length of the pool. The partner started the swimmer by holding her ankles in the side position. When she was ready the partner released her ankles and walked along the side of the pool counting each stroke. The swimmer was recalled to start again if, in the opinion of the instructor, the swimmer pushed off from the side. Any part of a stroke was counted as a whole stroke.

4. Drownproofing.

For drownproofing (15) the body was in a relaxed prone float with the arms and legs hanging relaxed. The swimmer pressed her hands down in front of her face and lifted her head to get a breath. The object of the test was to take the least number of breaths possible in one minute but to exhale continuously while the head was in the water. The swimmers were not allowed to tread during each breath. The instructor started the minute with "Ready, Go!" and ended it with "Stop." The first breath and every breath taken during the time was counted. One-half of the group was in the deep water while the partners stood on the edge of the pool to score.

5. Plunge Dive

One side of the pool was marked off in five-foot intervals with black tape. The diver was instructed to dive in and glide underwater as far as possible with no arm pull or leg kick. The instructor walked along the deck of the pool as the diver glided and measured to the point where her finger tips first broke the surface of the water.

6. Underwater Swim.

The underwater course, as diagrammed in the Appendix, yielded a possible six points. The swimmer was instructed to stand with her toes behind the starting brick, take one breath, swim under water, and turn as many bricks as possible in their numbered order. The instructor walked along the side of the pool observing the number turned. Each brick had a number painted on it, and the pattern of the course was explained so that the swimmers followed it with relative ease. Only a few advanced swimmers were able to turn all six bricks. The number of bricks turned seemed to discriminate fairly well between skill levels of underwater swimming.

In addition to being a desirable length, the Objective Test seemed to project a fun element for the girls which was a motivation as well. They readily understood the procedures. The battery could be given to a class of twenty students in one class period.

The six objective items were administered to a small number of swimmers in an experimental session during the fall semester. Then the items were administered to swimmers in fall intermediate swimming classes. The test was given two times to a group of from thirty-five to thirty-

eight girls within a period of one week. In a few cases, Christmas vacation fell between the two administrations. The purpose of this preliminary testing was to establish reliability coefficients for each item by the test-retest method. It also afforded an opportunity for determining the most efficient methods of administration.

The objective battery was then administered to swimmers in the four intermediate swimming classes at the beginning and the end of the spring semester. This was for the purpose of determining the initial and final skill level of each swimmer. The difference between these two scores was used as an achievement score.

SUBJECTIVE TEST

Intermediate swimming provides an opportunity for refining basic skills, learning more complex ones, and building endurance in both. With this premise in mind, a second test battery, consisting of the nine items, was devised along with a rating scale for each item. Five strokes and four other skills were selected to be fairly illustrative of the intermediate level. These items formed the Subjective Test battery:

1. Front Crawl
2. Back Crawl
3. Side Stroke
4. Elementary Back Stroke
5. Breast Stroke
6. Surface Dive and Underwater Swim
7. Front Tuck Somersault
8. Treading Water
9. Standing Front Dive

These five strokes presented several patterns of arm and leg movements, breathing, and coordination in addition to the prone, back, and side body positions. The surface dive and swim underwater called for controlled arm movements to submerge in addition to propelling the body, maintaining the depth, and controlling breathing. The front tuck somersault represented the development of the kinesthetic sense under water. The swimmer must be able to perceive this new position before she can understand the mechanics of it. The absence of gravity leaves nothing except this sense to determine the body position in relation to the surface of the water. Proper sculling is essential to the execution of the stunt. Treading water is necessary for feeling secure in deep water. It also provides proficiency in a safety skill. The ease and relaxation evident in this skill could be an indication of confidence. Torney (8) and Smith (7) stressed the importance of these factors. Entering the water head first required timing as well as the confidence of the diver that she would be able to return to the surface of the water.

The choice of these items was determined by face validity. It was hoped that these items would provide a fair measure of swimming ability. This was affected by the quality of the rating scale and the consistency of the judges. Refinement of these skills through practice and concentration constituted the core of the intermediate swimming course.

Rating Scales

Rating scales were constructed with values of from one to five.

Five represented the highest score, and zero indicated no attempt. There was one scale for the five strokes and an individual scale for each of the other four skills. These scales are listed in the Appendix.

Three judges rated the form of each swimmer on each of the nine items. The individual's final score was a total of the ratings awarded by the three judges on each item. Swimmers in all four classes were judged by the two instructors, each teaching two classes, and one other member of the Department of Physical Education.

Administration of the Subjective Test

The swimmers were lined up alphabetically in groups of four and their names were written on each judge's score sheet in that order. Each line swam the specified stroke one length of the pool while the judges rated the four swimmers.

The surface dive and underwater swim were done in staggered formation from the deep end so that each swimmer could be observed individually. The front tuck somersault was also performed in staggered formation in medium depth water. Treading water was judged by having a line of four swimmers tread at one time. The standing front dive was done from the deep end of the pool by having each group line up, and then each girl dived in individually.

This battery was easily administered to twenty girls in one class period and seemed to present items which most could attempt in the initial testing and perform with greater ease in the final testing.

The Subjective Test was administered to the swimmers in the four intermediate classes at the beginning and end of the spring semester.

This was done for the purposes of correlating the scores on the Subjective Test and the Objective Test to establish the validity of the Objective Test and to determine a relationship between General Motor Ability and achievement in swimming.

SCOTT GENERAL MOTOR ABILITY TEST

The Scott General Motor Ability Test (13) was chosen as the battery for measuring motor ability. The three-item battery, including the obstacle race, the basketball throw for distance, and the standing broad jump, was selected.

The test was administered to the swimmers in the four intermediate classes on a designated evening. This was before their first lesson in the water. A T-score for each girl was calculated from the norms established at The Woman's College of the University of North Carolina. These motor ability scores were correlated with the achievement scores obtained on the Objective and Subjective Tests to obtain a relationship between General Motor Ability and achievement in intermediate swimming.

STATISTICAL TECHNIQUES

The statistical analyses included five procedures which were used to establish the Objective Test and to determine a relationship between General Motor Ability and achievement in intermediate swimming.

T-Scales

T-scales were constructed for the final scores and for the difference scores on each item of the Objective Test. The difference scores represented the difference between the initial and the final scores. The

sum of the final T-scores and of the difference T-scores was then known as the Final Objective Score and the Objective Difference Score, respectively. These scores were used in succeeding calculations.

Rho Coefficients of Correlation

The Rho Coefficients of Correlation Method was employed to obtain coefficients of intercorrelation between the three judges' ratings for each of the nine items of the Subjective Test. Each of the four classes was correlated as a separate group. This was to establish the reliability of the three judges for each item in each class.

t test of the Difference Between the Means of Matched Pairs

This technique was used on the initial and the final scores of the Objective Test. It indicated whether or not there was a difference between those scores obtained during the initial testing and those obtained during the final testing.

The Pearson Product Moment Method

A large portion of the statistical procedure utilized this method for correlations. Coefficients were obtained after the following groups of scores were correlated:

1. The reliability of the Objective Test items was determined by correlating scores on the two administrations of the battery during the fall semester.

2. The intercorrelations of the three judges' ratings on each of the nine items of the Subjective Test determined the agreement of the judges on the final administration. The members of the

four classes were treated as one group.

3. Intercorrelations of the total scores for each swimmer determined the agreement of the total score awarded to each girl by each judge. These coefficients, based on the total ratings, were obtained for the initial as well as for the final administrations.

4. The sums of the judges' ratings for the final Subjective Test were correlated with the sums of the final T-scores of the Objective Test to establish the validity of the Objective Test.

5. The Objective Difference Scores and the Subjective Difference Scores were correlated with General Motor Ability scores to establish relationships between General Motor Ability and achievement in intermediate swimming.

Correlation Ratios

Two of the Pearson Product Moment correlations showed a curvilinear tendency on the scattergram plotting. This caused the writer to think that perhaps the correlations were really higher than this method of correlation revealed. Consequently, the Correlation Ratios technique was employed to exploit the possibility of the presence of a fatigue curve which would have a tapered pattern. This method was used for two correlations to establish the validity of two of the items on the Objective Test.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

There were two purposes to this study. The first was to determine a relationship between General Motor Ability and achievement in intermediate swimming. The second was to establish objective measurement indices in swimming, specifically at the intermediate level.

The participants in this study were seventy college women enrolled in four intermediate swimming classes during the spring semester, 1962, at The Woman's College of the University of North Carolina.

A discussion of each statistical procedure follows which includes the treatment of data, the analysis of data, and the interpretation of findings for each table. Data on the objective test are discussed first in the sequence.

RELIABILITY COEFFICIENTS FOR THE OBJECTIVE TEST--TABLE I

Two administrations of the objective test were given to establish a reliability coefficient for each of the six items. Thirty-eight girls, who were in fall semester classes of intermediate swimming, took the test twice. Most of the girls took the tests within a period of one week near the end of the semester. In seven cases, however, Christmas vacation fell between the first and second testings.

The Pearson Product Moment Method (5) of correlation was used to correlate the scores on the first and second trials for each of the six items. There are several explanations for situations which may have

TABLE I

RELIABILITY COEFFICIENTS OF CORRELATION BETWEEN THE FIRST AND SECOND TRIALS ON EACH ITEM OF THE OBJECTIVE SWIMMING TEST

Item	N	r
1. Flutter Kick	38	.8459
2. Sculling	38	.7354
3. Side Stroke	38	.7215
4. Drownproofing	35	.6138
5. Plunge Dive	37	.7950
6. Underwater Swim	36	.7589

influenced these coefficients.

1. A three-week interval fell between the testing of seven cases. Since no coefficient was lower than .6138, perhaps this means that the test was fairly reliable over a period of time. However, this same time element would be the very kind of factor that would tend to lower the established reliability.

2. Drownproofing, which had the lowest coefficient of .6138, was unfamiliar to the group. Most of them had not attempted it before the first testing. Therefore, more learning could have taken place between the testing periods.

3. Although they understood the procedure, several girls indicated that the second time they realized that the side stroke was to be done with the least number of strokes possible. This may have influenced the correlation on this item.

4. Objective testing is not particularly common in swimming. Therefore, the girls may not have been as accustomed to skill tests in swimming as they would have been in other sports.

5. These correlation coefficients as shown in Table I ranged from .8459 to .6138 and were considered satisfactory.

JUDGES' RATING ON THE SUBJECTIVE TEST

Agreement of the Judges on the Initial Ratings--Tables II and III

Three judges rated each swimmer in four classes on nine items of the subjective battery to establish the initial skill level of each student. The Spearman Rank-difference Correlation Method (5) was used to ascertain the agreement between the judges. Correlation coefficients

TABLE II

RHO COEFFICIENTS INDICATING THE INTERCORRELATION BETWEEN THE INITIAL JUDGES' RATINGS ON EACH OF THE NINE ITEMS FOR EACH OF THE FOUR CLASSES

Items and Judges	Classes A N = 20	B N = 16	C N = 16	D N = 23
1. Front Crawl				
1 - 2	.5989	.7450	-.5264	.3159
1 - 3	.6994	.5552	-.3674	.6455
2 - 3	.6796	.6853	.1928	.4727
2. Back Crawl				
1 - 2	.6490	.8214	.3782	.5722
1 - 3	.7719	.9216	.4055	.7034
2 - 3	.8297	.6551	.6512	.7439
3. Side Stroke				
1 - 2	.8712	.7701	.6180	.6457
1 - 3	.8663	.8608	.5793	.7415
2 - 3	.8502	.8684	.7476	.7427
4. Elementary Back Stroke				
1 - 2	.8064	.5498	.4492	.5716
1 - 3	.8778	.7958	.4222	.7957
2 - 3	.9165	.7292	.1712	.6389

TABLE II (Continued)

Items and Judges	Classes A N = 20	B N = 16	C N = 16	D N = 23
5. Breast Stroke				
1 - 2	.8795	.7115	.2857	.8156
1 - 3	.7878	.6456	.5304	.8798
2 - 3	.8697	.7206	.6542	.7654
6. Surface Dive and Underwater Swim				
1 - 2	.7019	.8944	.7465	.6183
1 - 3	.8008	.9800	.6689	.6259
2 - 3	.8517	.9148	.7602	.3925
7. Front Tuck Somersault				
1 - 2	.6266	.9319	.7853	.8105
1 - 3	.9191	.8464	.8101	.7349
2 - 3	.4962	.8895	.5509	.6466
8. Treading Water				
1 - 2	.1843	.4308	-.5875	.4319
1 - 3	.8300	.6315	.2387	.5081
2 - 3	-.1118	.2177	-.2738	.4179
9. Standing Front Dive				
1 - 2	.6510	.8899	.1727	.7642
1 - 3	.6918	.8912	.5685	.7821
2 - 3	.7164	.8973	.6269	.8351

TABLE III

CUMULATIVE PERCENTAGES SHOWING THE GROUPING OF THE COEFFICIENTS IN TABLE II IN INTERVALS OF .10

N = 108

Coefficient Intervals	Frequency Sum	Cumulative Percentage
.90 and above	6	5.555
.80 and above	25	28.703
.70 and above	23	50.000
.60 and above	21	69.444
.50 and above	10	78.703
.40 and above	8	86.111
.30 and above	3	88.888
.20 and above	3	91.666
.10 and above	4	95.370
0 and above	0	
-.10 and above	0	
-.20 and above	1	96.296
-.30 and above	1	97.222
-.40 and above	1	98.148
-.50 and above	0	
-.60 and above	2	100.000

were calculated between the three judges for each of the nine skills in each of the four classes as reported in Table II. There are several observations which can be made concerning these coefficients.

1. The ratings correlated relatively high as a whole.

2. Class C tended to produce lower coefficients for all of the items. The other three classes were similar. The writer cannot account for this discrepancy.

3. Item number eight, treading water, had the lowest overall coefficients. The judges disagreed most on this item. There are several approaches to the teaching of treading water, and the judges may have had more diverse views of this skill. It is probably the least well-defined skill of the nine items rated.

4. Four of the five negative coefficients occurred in Class C, which produced the lowest coefficients of the four classes. They occurred in only two skills: the front crawl and treading water.

Two factors may have been responsible for some of the lower coefficients.

1. The Spearman Rank-difference Correlation Method is a rough measure in itself. It was greatly influenced by the number of cases, which in this instance ranged ranged from sixteen to twenty-three for the four classes. The Method of Dealing With Ties (5) was applied when more than three numbers were tied. This was used as many as five times in a single correlation since the rating scale contained only five divisions. Therefore, a more refined

instrument might have yielded a higher reliability.

2. The rating scale contained only five divisions. This would have been satisfactory for judging beginning intermediate or final intermediate skill, but it did not seem large enough to include both. If a scale with more than five points had been used, it might have yielded a more discriminating and accurate measure.

Table III presented the cumulative percentage of the judges' intercorrelations by tenths. It indicated that fifty per cent of the judges' intercorrelations yielded coefficients of over .70. Almost eighty per cent of them were above .50. These percentages contributed a summary which indicated that the group of coefficients, as a whole, was acceptable.

Agreement of the Judges as Indicated by the Initial Total Scores--Table IV

The sum of the scores awarded each swimmer by each judge was to be used in successive procedures. Consequently, a correlation of the total scores between the three judges was of interest. All three of the coefficients were acceptable. This indicated the agreement of the judges on the total test instead of on the individual items as reported in Table II. Fairly high coefficients were anticipated since so many skills were included in the battery. These coefficients, ranging from .9257 to .8537, gave confidence to the writer that the three judges were in ample agreement.

Agreement of the Judges on the Final Ratings--Table V

The same three judges rated each girl on the nine items of the subjective battery at the end of the lessons to establish her final skill

TABLE IV

COEFFICIENTS OF CORRELATION INDICATING THE INTERCORRELATIONS BETWEEN THE INITIAL TOTAL SCORES AS RATED BY THE THREE JUDGES

N = 81

Judges	r
1 - 2	.8537
1 - 3	.9257
2 - 3	.8953

TABLE V

COEFFICIENTS OF CORRELATION INDICATING THE INTERCORRELATIONS BETWEEN THE FINAL SUBJECTIVE RATINGS FOR EACH OF THE NINE ITEMS AND FOR THE TOTAL SCORES AS RATED BY THE THREE JUDGES

N = 70

Item	Judges 1 - 2 r	1 - 3 r	2 - 3 r
1. Front Crawl	.5827	.5878	.6328
2. Back Crawl	.5705	.5693	.7132
3. Side Stroke	.6116	.6768	.6331
4. Elementary Back Stroke	.5511	.7021	.6295
5. Breast Stroke	.5857	.8185	.6433
6. Surface Dive and Underwater Swim	.7707	.8093	.8420
7. Front Tuck Somersault	.7165	.8335	.8545
8. Treading Water	.5674	.4698	.6160
9. Standing Front Dive	.6323	.8060	.6769
10. Total Scores	.7876	.8562	.9101

level. The members of the classes were combined into one group for statistical calculations. The classes were not treated individually in the final calculations. The coefficients obtained on the initial testing gave confidence to the writer that the judges were fairly well in agreement. Their experience from the initial ratings should have been a favorable factor in producing high coefficients on the final administration.

The Pearson Product Moment Method (5) of correlation was used to determine the agreement of the final judges' ratings. Coefficients of correlation were calculated between the three judges' ratings on each of the nine items as well as on the total scores. The coefficients seemed acceptable as a whole. The range was from .8335 to .4698 for the nine items. There was only one coefficient below .50. Here, as in the intercorrelations of the initial ratings, the treading item seemed to be the one the judges had the most difficulty rating. The three correlations between the total scores were used in subsequent calculations. These coefficients (.9101 to .7876) seemed quite respectable.

Validity Coefficients for the Objective Test--Table VI

The final raw scores on each of the six items in the Objective Test were correlated with the sums of the judges' ratings on the Subjective Test. T-scales were constructed for all six items. This gave equal importance to each item. No attempt was made to weight the items. The sum of the six T-scores for each subject was correlated with the sum of the subjective ratings. The Pearson Product Moment Method (5) of correlation was used to establish the validity of each item and of the

TABLE VI

VALIDITY COEFFICIENTS OF CORRELATION BETWEEN THE SUBJECTIVE RATINGS AND THE SEPARATE ITEMS OF THE OBJECTIVE TEST AS WELL AS THE COMPOSITE T-SCORES

N = 70

	Item	r	Correlation Ratios	
1.	Flutter Kick	.4618*	.5883	.6327
2.	Sculling	.5949*		
3.	Side Stroke	.5977*		
4.	Drownproofing	.2523**		
5.	Plunge Dive	.6457*		
6.	Underwater Swim	.6002*	.6100	.6966
	Composite T-Scores	.7501*		

*Significant at the one per cent level of confidence.
**Significant at the five per cent level of confidence.

test battery. Several observations can be made concerning the coefficients.

1. The individual items measured different skills. Each represented only one phase of swimming. Therefore, it may well be that no single item correlated highly with the subjective score since it represented a composite of skills.

2. The scattergram plottings of the flutter kick and the underwater swim were curvilinear. This characteristic is often present in performances which reach a leveling-off point, as in cases of fatigue. With the Correlation Ratio (5) technique, eta coefficients were calculated to produce a better defined measure of correlation for these two items. The coefficients obtained brought the validity of the flutter kick within the range of the other items. The validity of the underwater swim proved to be one of the highest in the group.

3. Drownproofing was retained in the battery since the correlation coefficient of .2523 was significant at the five per cent level of confidence. It was intended as a method of measuring relaxed rhythmical breathing.

4. The coefficient of correlation between the objective battery and the total subjective battery of .7501 seemed quite acceptable and indicated that the six item battery was a fair measure of intermediate swimming skill.

The basis for selecting these items was from the categories which Cureton (4) established for the beginning level. One item was chosen to represent six of each of the seven categories as listed on page 12. He determined the percentage contribution of each group to the total score

with the Multiple Regression Technique. The Tetrachloric Correlation Method was used to establish the validity of each group with one item, a combination of beginning skills, as the criterion. There are similarities between his findings and the findings of this study.

1. Breathing and floating made no contribution to the total score, according to Cureton. This could be one explanation for the lower validity coefficient obtained in this study for drownproofing.

2. Diving skills made the highest single contribution to the total score in the Cureton study with a percentage of 61.81. Cureton also found validity coefficients of from .62 to .58 for diving. Diving had the second highest validity coefficient of .6457 in this study. It was outranked by only one of the coefficients for the underwater swim. This closely parallels his findings.

3. The highest coefficients Cureton found were from .95 to .72, and these involved the coordination skills of actual swimming. The next highest coefficients were for those skills which he felt involved a glide, such as underwater swimming and diving. These coefficients were from .68 to .61. He found that submerged activities, again, such as diving and underwater swimming were close, with coefficients from .62 to .58. In this study the coefficients for each item were similar with the exception of drownproofing. Also the highest limit of the coefficients was slightly lower in this study.

4. The greatest difference between the findings concerned

the side stroke. It was selected to represent one of the co-ordination skills. The highest validity Cureton obtained was from that skill group. However, in this study, the side stroke yielded a coefficient of .5977, which was neither the highest nor the lowest, yet substantial.

This statistical technique concluded the procedure which established an objective swimming test for the intermediate level with a satisfactory reliability and validity.

RELATIONSHIP OF ACHIEVEMENT TO GENERAL MOTOR ABILITY

The Difference Between Scores on the Initial and Final Objective Test--Table VII

The null hypothesis was formulated concerning the difference between the group raw scores on the initial and final administrations of the Objective Test. The t test to measure the Significance of Difference Between Matched Pairs (5) was used on the initial and final raw scores for each of the six items of the Objective Test. The null hypothesis was rejected at the one per cent level of confidence in all six instances. This indicated that there was a significant difference between the scores on the initial and final administrations. The test did discriminate between the two skill levels. This also indicated that the skill of the group changed during the lessons.

Correlations Between General Motor Ability and Achievement in Swimming--Table VIII

The difference was found between the initial and the final scores earned by each girl on all six items of the Objective Test. These

TABLE VII

THE SIGNIFICANCE OF DIFFERENCE BETWEEN THE INITIAL AND FINAL SCORES ON EACH ITEM OF THE OBJECTIVE TEST

N = 70

Item	t
1. Flutter Kick	3.2562*
2. Sculling	4.1709*
3. Side Stroke	7.4227*
4. Drownproofing	5.5525*
5. Plunge Dive	6.6625*
6. Underwater Swim	6.8921*

*Significant at the one per cent level of confidence.

TABLE VIII

COEFFICIENTS OF CORRELATION BETWEEN THE DIFFERENCE SCORES (ACHIEVEMENT) AND GENERAL MOTOR ABILITY

N = 70

	r
Objective Difference Scores vs. General Motor Ability Scores	.0292
Subjective Difference Scores vs. General Motor Ability Scores	.0405

Difference Scores were converted into T-scores. The sum of the T-scores for each girl was known as the Objective Difference Score. The Subjective Difference Score consisted of the difference between the sums of the initial and the final judges' ratings. These two scores represented the achievement of seventy intermediate swimmers during a series of twenty-five lessons. The difference between their initial and final scores on both tests was used to indicate the amount of progress.

A purpose of this study was to establish a relationship between General Motor Ability and achievement in swimming at the intermediate level. The Pearson Product Moment Method (5) of correlation was used to analyze the Objective Difference Scores with the General Motor Ability scores and the Subjective Difference Scores with the General Motor Ability scores. The coefficients of .0292 and .0405, respectively, suggested no correlation between achievement in swimming and General Motor Ability. This was true whether achievement was measured objectively or subjectively.

None of the studies reviewed in Chapter II dealt directly with motor ability and achievement in swimming. They were concerned with rate of learning rather than achievement and with beginning rather than intermediate swimmers. Scott (14) conducted the only study which found an acceptable positive relationship. A coefficient of .52 was significant at the two per cent level of confidence. This was a correlation between the learning rate of twenty beginning swimmers and their scores on the Scott General Motor Ability Test.

The low correlations found in this study indicated no relationship

between General Motor Ability and achievement in swimming at the intermediate level. Therefore, a person who scores high on the General Motor Ability Test may not necessarily attain a high degree of achievement in swimming. According to this study, performance on the General Motor Ability Test was not an acceptable predictor of what to expect of these girls in swimming achievement at the intermediate level. There are several interpretations to consider as explanations for these low coefficients.

1. Those elements which determine skill in movement may assume new dimensions when the body is submerged in water. Therefore, skill in the water may be unrelated to other sports skills.

2. The additional components of resistance, relaxation, breathing, buoyancy, and fear present new elements with which the swimmer must learn to contend. The General Motor Ability Test was constructed to measure skills on land. Proficiency in skills on land may not be affected by any of these elements to as great a degree as in the water. Therefore, the General Motor Ability Test may not be an indication of motor ability in swimming.

3. The intermediate level was selected for study in an attempt to minimize the inconsistency of performance and fear. It is inevitable that some degree of fear or doubt prevailed in some swimmers. This is a variable which cannot be controlled. A portion of those who were unsure or scared may

have overcome this condition during the course and shown the greatest achievement. Others may have been restrained for the duration of the period.

The two purposes of this study were (1) to establish a relationship between General Motor Ability and achievement in intermediate swimming, and (2) to establish objective measurement indices for intermediate swimming. The study was conducted with seventy intermediate swimmers participating. No relationship was found between General Motor Ability and achievement in intermediate swimming. An Objective Test battery with an acceptable reliability and validity was established.

CHAPTER V

SUMMARY AND CONCLUSIONS

The two purposes of this study were (1) to determine a relationship between General Motor Ability and achievement in swimming at the intermediate level, and (2) to establish objective measurement indices in intermediate swimming. The subjects were seventy college women who enrolled in four intermediate swimming classes for the spring semester, 1962, at The Woman's College of the University of North Carolina.

Three tests were administered to the group during the study. An Objective Test containing six items was devised by the author. It was given to the group at the beginning and end of the semester to ascertain the initial and final skill levels. A Subjective Test was formulated. It included nine items representative of Intermediate skills and a rating scale for each. This battery was also administered at the beginning and end of the semester. The Subjective Test scores were used to establish the validity of the Objective Test. The Scott General Motor Ability Test was chosen to measure motor ability. It was administered at the beginning of the semester. The difference scores between the initial and final scores on both the Objective Test and the Subjective Test were used as measures of achievement to correlate with the General Motor Ability scores.

Intercorrelation coefficients were computed for the judges' ratings on the Subjective Test. The findings indicated the following points to be true for this particular group of girls:

1. The intercorrelations of the three judges' ratings on the individual items showed that the judges were in fairly close agreement for most of the skills.

2. Intercorrelations of the total scores awarded to each subject by each judge revealed that the agreement of the judges was quite satisfactory. This also meant that the sum of the total scores awarded by the judges was a good measure of swimming skill which could be used in subsequent calculations.

The reliability of the Objective Test was established. The validity was established by correlating the scores of the individual items and the composite T-scores of the Objective Test with the total scores of the Subjective Test. The following conclusions seem justified:

1. Acceptable reliability coefficients were obtained for each of the six items.

2. There was no single item which yielded a high validity coefficient, yet all six of the items were of sufficient value to be included in a battery.

3. An excellent validity coefficient of .75 was obtained for the total Objective Test.

The Objective Difference Scores and the Subjective Difference Scores were accepted as measures of achievement. These scores were correlated with the General Motor Ability scores. The coefficients of .0292 and .0405 served as the bases for drawing the following conclusions:

1. According to this study, there was no relationship between General Motor Ability and achievement in intermediate swimming. Therefore, performance on the General Motor Ability Test was not an acceptable predictor of what to expect of these girls in swimming achievement at the intermediate level.

2. This was true whether achievement was measured objectively or subjectively.

The conclusions of this study indicated that for these seventy college women there was no relationship between General Motor Ability and achievement in intermediate swimming. An Objective Test battery with an acceptable reliability and validity was established for the intermediate level.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

1. Broer, Marion R. Efficiency of Human Movement. Philadelphia: W. B. Saunders Company, 1960. 351 pp.

2. Cureton, Thomas K., editor. Beginning and Intermediate National Y. M. C. A. Progressive Aquatic Tests. New York: Association Press, 1938. 59 pp.

3. _____. How To Teach Swimming and Diving. New York: Association Press, 1934. 238 pp.

4. _____. Standards For Testing Beginning Swimming. New York: Association Press, 1939. 190 pp.

5. Guilford, J. P. Fundamental Statistics in Psychology and Education. Second edition, New York: McGraw-Hill Book Company, Incorporated, 1950. 633 pp.

6. Smith, Ann Avery. Skillful Swimming. Ann Arbor, Michigan: J. W. Edwards, Incorporated, 1954. 213 pp., citing McConnell, T. R. and others. The Forty-First Yearbook of the Society for the Study of Education, Part II, The Psychology of Learning. Bloomington, Illinois: Public School Publishing Company, 1942, p. 185.

7. _____. Swimming and Plain Diving. New York: Charles Scribner's Sons, 1930. 247 pp.

8. Torney, John A. Swimming. New York: McGraw-Hill Book Company, Incorporated, 1950. 315 pp.

B. PERIODICALS

9. Berg, B. Robert. "Psychology in Teaching Swimming," Recreation, 43:258-259, August, 1949.

10. Cureton, Thomas K. "Standards for Testing Beginning Swimming," The Research Quarterly, 10:54-59, December, 1939.

11. Fox, Margaret. "Swimming Power Test," The Research Quarterly, 28: 233-237, October, 1957.

12. Hewitt, Jack E. "Achievement Scale Scores for High School Swimming," The Research Quarterly, 20:170-179, May, 1949.

13. Scott, M. Gladys. "The Assessment of Motor Abilities of College Women Through Objective Techniques," The Research Quarterly, 10:63-83, October, 1939.

14. _____. "Learning Rate of Beginning Swimmers," The Research Quarterly, 25:91-99, March, 1954.

C. UNPUBLISHED MATERIALS

15. Berry, Anne Elise. "The Development of a Program of Survival Swimming and Lifesaving to be Taught as a Part of Beginning and Intermediate Courses in Swimming," Unpublished Master's thesis, The Woman's College of the University of North Carolina, Greensboro, 1960. 85 pp.

16. Deach, Dorothy Frances. "The Relation Between Tests of Motor Ability and Rate of Learning to Swim," Unpublished Master's thesis, The University of Illinois, Urbana, 1931. 24 pp.

17. Kuhl, Louise. "A Study of the Learning Rate of College Women in Certain Physical Activities as Related to Their General Motor Ability," Unpublished Doctoral dissertation, State University of Iowa, Iowa City, 1941. 71 pp.

18. McNeely, Frances Ehrlich. "A Comparative Study of Motor Ability and Rate of Learning Swimming Skills," Unpublished Master's thesis, The University of Texas, Austin, 1939. 64 pp.

19. Rogers, Dorothy Dow. "A Study of the Relationship Between Certain Measures of Swimming Achievement, Fear, Motor Ability and Rhythm Among College Women," Unpublished Master's thesis, State University of Iowa, Iowa City, 1934. 58 pp.

20. Solleder, Marian K. "Learning Rate in Treading Water," Unpublished Master's thesis, State University of Iowa, Iowa City, 1950. 31 pp.

APPENDIX

LESSON PLANS

INTERMEDIATE SWIMMING

Lesson 1:
- Announcements
- Explain the course objectives
- Explain the study
- Assign baskets

Lesson 2:
- Deep water test: 1 length, front crawl
- Review skills for tests: demonstrate, explain, and practice
  - back crawl
  - elementary back stroke
  - breast stroke
  - side stroke
  - sculling
  - surface dive and underwater swim
  - underwater swimming course
  - front tuck somersault
  - dives: standing and plunge

Lesson 3:
- Objective testing

Lesson 4:
- Ratings by judges

Lesson 5:
- Review breathing: bobbing
  - shallow water
  - deep water
  - partners
- Introduce front crawl
  - leg kick
  - arm stroke and breathing
  - combined
  - turn
- Lengths: 8, front crawl

Lesson 6:
Introduce back crawl
leg kick
double arm lift
single arm lift
combined
turns
Lengths: 4, front crawl; 4, back crawl

Lesson 7:
Introduce drownproofing (15)
Introduce elementary back stroke
leg kick
arm stroke
coordination
Introduce porpoise
hand stand
porpoise tag
Introduce front tuck somersault
Introduce surface dive and underwater swim
Lengths: 3, elementary back stroke; 3, front crawl;
3, back crawl

Lesson 8:
Review elementary back stroke
Introduce inverted breast stroke
leg kick
arm stroke
coordination
Introduce breast stroke
Lengths: 2, elementary back stroke; 2, front crawl;
2, back crawl; 2, inverted breast stroke; 2, breast stroke

Lesson 9:
Review drownproofing
Review strokes: 16 lengths
front crawl
back crawl
elementary back stroke
inverted breast stroke
breast stroke
Free time: 5-10 minutes

Lesson 10:
Warm-up: 5 lengths in succession
Introduce diving from the deck
kneeling
standing
arm lift

Lesson 11:
Practice drownproofing
Introduce finning with leg kick
Introduce sculling and the body position
Introduce the plunge dive
Lengths: 15, including 4 sculling

Lesson 12:
Warm-up: 4 dives
Introduce side stroke
leg kick
arm stroke
combined
Introduce inverted and overarm side strokes
Lengths: 2, regular; 2, inverted; 2, overarm

Lesson 13:
Warm-up: 6 lengths
Introduce springboard diving
jump
dive
jump with spring
dive with spring
practice approach on land
approach and jump
approach and dive

Lesson 14:
Review springboard diving
approach and jump
approach and dive
Introduce recreational activities
front pike fall-in
back pike fall-in
kickboard tug of war
Review front tuck somersault
Introduce back tuck somersault
Introduce tandem strokes
Lengths: 12, individual choice

Lesson 15:
Warm-up: 4 dives
Introduce safety techniques
reaches
extensions
15 minute endurance swim
Practice drownproofing

Lesson 16:
Introduce disrobing
Review tandem strokes
Review drownproofing
Lengths: 2 more than lesson before

Lesson 17:
General review
Stations according to water depth
deep: diving
medium depth: surface dive and underwater swim
somersaults
shallow: strokes
sculling

Lesson 18:
Show motion pictures on intermediate and advanced swimming

Lesson 19:
Review of whip kick strokes
elementary back stroke
inverted breast stroke
breast stroke
Review drownproofing
Lengths: 18, individual choice

Lesson 20:
Review flutter kick strokes
front crawl
back crawl
Review underwater swim
Lengths: 20, individual choice

Lesson 21:
Review side strokes
regular
inverted
overarm
Lengths: 20, individual choice

Lesson 22:
General review with emphasis upon test items
front crawl
back crawl
elementary back stroke
breast stroke
side stroke
sculling
surface dive and underwater swim
underwater swimming course
front tuck somersault
dives: standing and plunge
Lengths: 2 each of the above five strokes

Lesson 23:
Endurance swim: 22 lengths
Play water polo

Lesson 24:
Objective testing

Lesson 25:
Rating by judges

RATING SCALE

STROKES

Rating Value	Form Body position, Movement of arms and legs	Power Of arm and leg stroke, not speed	Rhythm And coordination	Relaxation Degree of
5	Excellent	Maximum	Correct	Complete, effortless
4	Only minor fault	Easily seen, but weak	Slightly uneven at times	Minimal amount of tension
3	Several minor faults	Lacking	Jerky and unsure	Noticeable tenseness
2	Acceptable, body position lower in water	None noted	Difficult, occasionally correct	Very little
1	Hardly recognizable	Struggles	Uneven	None

Arbitrary qualifications established by the judges:

1. A score no higher than 2 will be awarded for the front crawl if the swimmer does not use rhythmical breathing.
2. A score no higher than 3 will be awarded for either the elementary back stroke or the breast stroke if the swimmer uses the scissor kick or any kick other than the whip kick or wedge kick.

RATING SCALE

SURFACE DIVE AND UNDERWATER SWIM

Rating Value	Dive	Depth	Power
5	With ease, no struggle	Maximum	Maximum, with glide
4	Some effort	Medium	Near maximum, some glide
3	Several pulls and some effort in general	Definitely under	Little glide, can stay down, travels a short distance
2	Several pulls, struggles	Does get under	Difficulty in staying under
1	Never gets under, does attempt	None	None

RATING SCALE

FRONT TUCK SOMERSAULT

Rating Value	Body Position	Execution	Breathing	Body Control
5	From lay-out to tight tuck	Coordinated: pull, tuck, turn, and extend	Natural	Smooth
4	From lay-out to tuck	Coordinated, but jerky, some effort	Slight trouble	Parts are smooth
3	Does not start from lay-out, not tucked tightly	Accomplished	Trouble with nose	Unsure
2	Not lay-out, open tuck	Crooked	Water in nose	Slight or none
1	Not lay-out	Unfinished	Water in nose	None

RATING SCALE

TREADING WATER

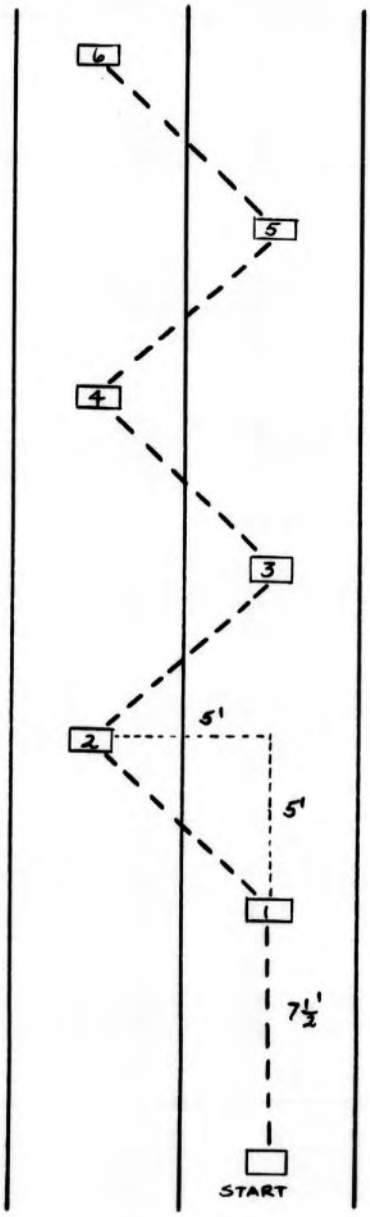
Rating Value	
5	Complete ease, barely moves, maintains stationary position, breathes easily, relaxed
4	With ease, appears to be slightly tense, breathes fairly easily, body position may vary
3	Tension noted, body bobs when force is applied, some difficulty breathing
2	Definite tension, manages to hold body up, bobs and moves in water, breathing difficult
1	Struggles, barely able to breathe, no relaxation

RATING SCALE

STANDING FRONT DIVE

Rating Value	Starting position and lift	Body position in air	Entry	Over-all effect
5	Standing straight, arms at side, use arm lift, spring simultaneous with lift	Extended stretch, maximum height	Straight, little splash	One flowing movement
4	Standing straight, use arm lift, spring	Extension, only slight knee bend, height present	Straight, some splash	Coordinated movement, but jerky
3	Standing straight, use arm lift, little or no spring	Extended, knees bent, force directed out instead of up	Lacks depth, similar to plunge, not fully extended	Slight hesitations between steps
2	Standing, to a bend or crouch, no spring	Unfold as reach forward	Head first	Beginning stage and steps
1	Crouch, no spring	Slight or no unfolding	Not necessarily head first	Not recognized as a dive

UNDERWATER SWIMMING COURSE



Specifications

2 Five-foot lanes

7 Bricks: 1 blank
6 with numbers 1-6 painted on them

Depth of water: 4-7'

Scale: 1" = 5'

---- Swimming Course

TABLE IX

T-SCALES FOR FINAL SCORES ON THE OBJECTIVE TEST

T-Score	Flutter Kick Seconds	Sculling Seconds	Side Stroke Strokes	Drown-proofing Breaths	Plunge Dive Feet	Under-water Swim Bricks
75	22	35			33	
74						
73						
72	23	36				
71						
70		37	7		32	
69	24			3		
68		38				
67		39				
66	25	40			31	
65						6
64		41				
63	26	42			30	
62		43				
61	27	44	8	4		
60					29	
59	28	45			28	
58		46				
57		47			27	
56	29	48-49				
55		50-51			26	
54	30	52	9	5		
53	31					
52	32	53				5
51	33		10		25	
50	34	54				
49	35	55		6		4
48		56	11		24	
47	36	57				
46	37	58			23	

TABLE IX (Continued)

T-Score	Flutter Kick Seconds	Sculling Seconds	Side Stroke Strokes	Drown-proofing Breaths	Plunge Dive Feet	Under-water Swim Bricks
45			12	7		3
44	38	59			22	
43	39	60	13		21	
42	40	61-62	14			
41	41	63-64		8	20	
40	42-43	65	15			2
39	44-45	66		9		
38	46-51	67-68		10	19	
37	52-53	69	16		18	
36	54-55	70-73		11	17	
35	56-57	74			16	
34	58	75-76	17	12		1
33	59	77-81	18-19	13		
32	60-61	82	20	14		
31	62-75			15	15	
30	76	83	21	16		
29	77	84-85		17-18		
28	78-88	86	22-23	19 and		
27	89-99	87		Below		
26	100-101	88	34			

TABLE X

T-SCALES FOR DIFFERENCE BETWEEN THE INITIAL AND FINAL SCORES ON THE OBJECTIVE TEST

T-Score	Flutter Kick Seconds	Sculling Seconds	Side Stroke Strokes	Drown-proofing Breaths	Plunge Dive Feet	Under-water Swim Bricks
75	57	67	35	15	13	5
74	56	66				
73					12	
72	51-55	65	34		11	4
71	46-50	64				
70	44-45	63	33	14	10	
69	24-43	62		12-13	9	
68	23	60-61		11		3
67	22	56-59	32	10		
66		45-55				
65	19-20	34-44	29-31	8-9	8	
64	18	30-33	28	7		
63	16-17	26-29	24-27			
62	14-15	24-25	20-23	6		
61	13	22-23	15-19			2
60	12	20-21		5	7	
59	11	18-19	13-14			
58	10	16-17	12	4	6	
57	9	14-15	11			
56	8	12-13	10			
55	7	10-11	8-9	3	5	
54	6	9	7			
53		8	6		4	
52	5					1
51		7	5	2	3	
50	4	6				
49		5				
48	3	4	4		2	
47				1		
46	2	3	3			

TABLE X (Continued)

T-Score	Flutter Kick Seconds	Sculling Seconds	Side Stroke Strokes	Drown-proofing Breaths	Plunge Dive Feet	Under-water Swim Bricks
45					1	
44		2	2			
43	1					0
42	0	1				
41		0	1	0	0	
40	-1	-1				
39	-2	-2				
38		-3--4				
37	-3	-5			-1	
36	-4	-6	0			
35				-1	-2	
34	-5	-7		-2		
33	-6			-3	-3	
32	-7--8	-8				
31	-9--10			-4		
30	-11	-9	-1		-4	-1
29	-12	-10				
28	-13--17	-11--18	-2--3	-5	-5	
27	-18--22	-19--26	-4--5		-6	
26	-23--24	-27--28	-6	-6	-7	

TABLE XI

GENERAL MOTOR ABILITY T-SCORES

Number	T-Score	Number	T-Score	Number	T-Score
1	69	25	55	48	48
2	50	26	54	49	42
3	55	27	65	50	48
4	34	28	41	51	62
5	63	29	55	52	54
6	53	30	59	53	46
7	60	31	53	54	60
8	42	32	60	55	39
9	67	33	69	56	58
10	65	34	51	57	63
11	38	35	60	58	63
12	55	36	58	59	55
13	54	37	53	60	78
14	65	38	66	61	53
15	61	39	59	62	42
16	60	40	58	63	60
17	63	41	59	64	59
18	58	42	51	65	54
19	62	43	31	66	54
20	59	44	46	67	56
21	64	45	63	68	56
22	62	46	65	69	46
23	69	47	50	70	63
24	53				

Typed by

Elizabeth Booker