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An experimental testing of ability and progress in swimming

Walter J. Osinski
University of Massachusetts Amherst

AN EXPERIMENTAL TESTING OF ABILITY & PROGRESS IN SWIMMING

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By

Walter J. Osinski

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INTRODUCTION

Terminology in the comparatively new field of physical education is not sharply defined. Many terms are used by different writers to signify the same quality. Such terms as physical ability, athletic ability, physical capacity, physical achievement, motor ability, native motor ability and many others, have all been used to indicate the measurement of the skill of the body. Obviously, some of these terms are applicable to the present problem and some are not.

The term physical or motor capacity connotes potential as well as actual, and native rather than acquired ability, hence, could not be applied to the present study. Also an individual may have the capacity to do a thing and not the skill to do it.

Since this experiment is concerned with the present ability and noted progress, there is no attempt made to isolate native ability; however, there are some physical educators who believe that native motor ability can be measured. Inasmuch as the child from birth is subjected to the training of others, it seems difficult to imagine that native motor ability, or the motor ability with which the child is born, could be isolated from the effect of education and measured at the age of twenty, thirty, or fifty. We are accustomed to think of native ability as a constant thing; thus, if we gave a test to measure native motor ability and

found that the individual could not pass the test, then we would concede that he was lacking in that particular native ability. If, however, we gave the test a second time and it was passed, then we must concede that at least part of the ability was acquired.

Ability usually connotes such qualities as arise from training and indicates actual skill rather then potential alone. The term motor seemed to be significant in this case since this experiment is an effort to measure aptitudes in the specific activity of swimming.

Progress as defined in this testing can be said to be the forward movement in improvement that can be recognized by the various tests to be presented and noted.

This experiment is an attempt to develop and use some tests and measurements in the field of motor ability and in the specific activity of swimming. Although there has been considerable work attempted in the field of physical efficiency, very little has been attempted in the field of motor ability tests.

During my undergraduate days, varsity players, competitive games, and coaching received most of my attention in physical education. With the advent of new ideas in "carry over" activities for later life, my interest changed. There has been considerable attention given to the varsity player and consequently neglect for the members of the physical education classes. It is this particular group that needs

to be encouraged and helped, but which is altogether too often left to its own resources. Therefore my interest in this problem centers around two phases of measurements. The writer wanted first to devise a means of determining the progress of an individual in the learning of specific motor skills, and second to develop a combination of tests which when applied might prove an index to swimming ability.

This study concerns itself around:

1). Can a series of tests be developed which would adequately measure progress in swimming?

2). Can a series of tests be developed which might be used as a means of predicting potential swimming ability?

Before expounding my tests and procedure, I would like to make a notation at this point in regard to limitations of this experiment.

LIMITATION OF EXPERIMENT: Owing to the fact that this type of experiment can be applied to hundreds of swimmers, the writer has had to be content with as many as could be secured. In fact, the experimental group consisted of about the type of student who really needed instruction in swimming and therefore the Amherst High School boys who assisted really served the purpose. As for the number, it was a typical physical education class of the high school caliber and thus sufficed for the problem.

LIMITATIONS OF STATISTICS: There are numerous statistical analyses that could have been carried on in the face of the material but would have exerted little or no influence upon my task. Since there has never actually been an experiment of this nature conducted, the limitations had to be curtailed. With progress as the key, data so limited, and statistics so varied, the arithmetical means has been the only means of tabulating and recording progress. As for correlations, they have no particular respect in regard to this task. The raw scores of each test have been properly placed in relation to other students and so no further tables were needed.

ORIGIN AND HISTORY OF SWIMMING

Historical pageants (3) usually portray savage man first swimming by using a stroke which is related to the crawl in its simple fundamental co-ordinations. This stroke, used as a means of escape from wild animals, may be described as an attempt to run in the water while in a horizontal position. These motions resemble somewhat a crude dog-paddle which has the rudimentary movements of the crawl. Whether these movements really were those which man naturally used in running, or were definitely controlled movements made in imitation of animal movements (6) in the water, is only conjecture. It is significant that the running co-ordinations are similar to those used in our dog-paddle.

Professor James E. Dunlap, archaeologist from the University of Michigan, has found considerable evidence that somewhat modern swimming methods were used 3,000 years ago. (5) He says,

"They swam the crawl centuries ago in Greece using a stroke almost identical with the overhand stroke today. Leander swam the Hellespont with this stroke, practically the same one which is being used to break swimming records today. The stroke is undeniably an overhand stroke very similar to the modern crawl, even to the kick of the legs. One picture showing Leander swimming was taken from the mosaic decoration of a great public bath of Henchir THINA,

the ancient THENAE, in the province of Byzacium in northern Africa. Another picture of Leander swimming was taken from the ruins in Pompeii and its essential features are the same. Leander was probably a legendary hero but people living at the time these mosaics were constructed were familiar with the overhand stroke.

This method was not confined to Greece and Rome. The peoples of the Nile, in Egypt, have left records of their achievements. A nobleman of the Middle Kingdom (2160-1780 B.C.) proudly recorded the fact that his children took swimming lessons with the children of the king. Among the best known ancient reliefs are those telling the story of the battle between Rameses II and the Hittites at Kadesh on the Orontes River in northern Syria (1292-1225 B. C.) after which the Hittites swam the river. One fleeing Hittite employing an overarm stroke in which the arms work alternately and the legs move in opposite directions in parallel planes. Reliefs from Nineveh show Assyrian soldiers crossing the Euphrates River using an overhand stroke. The Assyrians sometimes inflated skins as water wings for artificial support."

Livingstone (15) sketches ancient history of swimming covering tho participation in swimming as a part of religious festivities. He also describes the swimming of the Romans and Greeks. He makes reference to the fact that the Romans held swimming races but there are no authentic records.

While there are numerous references to the fact that people swam to some extent from this ancient period up to the writing of the first work on swimming technique in 1538, this period was truly the dark ages for swimming as well as other forms of learning.

The first swimming book was written by Nicolas Winnmann,(23) a professor of languages at Ingolstadt in Bavaria, Germany, and published in 1538.

CAPT. de la PEROUSE(13) on a trip around the world in 1785 refers to the Indian or natives of Easter Island, one of the South Sea Islands, as remarkable swimmers using over-hand strokes. This location is in the Southern Pacific off the coast of South America.

With the opening of the nineteenth century, a definite advance may be detected in European swimming. There were several important developments about this time which were certainly fore-runners of important events to come later. One of the interesting developments was that of QUADRIPED SWIMMING as described by J. Frost in his book written in 1818.(7) This was a stroke like our dog-paddle and very much like the earliest conceptions of the Austrian Crawl.

In his most excellent book "The Swimming Instructor" written in 1883(22) by William Wilson, he records some interesting data which tell of the beginning of the popularity of the improved English side-overarm stroke.

"Harry Gurr and Harry Gardner, now of Woolwich, were the first, who by lifting one hand out of the water and carrying it in the air beyond the head, won many races of importance; and these clever exponents of the art deserve every praise for their efforts and perseverance in introducing what was, at one time, looked upon as a style peculiar to and only used by themselves..... Soon, however, after these swimmers had pulled off several important prizes, it appeared evident that there was more in the innovation than was first apparent, and, after repeated trials and private rehearsals, those who had at one time laughed at the new movement considered it not beneath their dignity to follow in the wake of the swimmers just named, and the swimming master of the Victoria Park Lake, was, we think, the first teacher of this made of swimming, and to him is due a large need of praise for his efforts in this direction.

Up until the appearance of John Baptiste Johnson in London in 1871, this overhand stroke had been only practiced with a short reach, the uppermost hand dipping close to the head, and with the whole arm bent almost like a hook. Until the brothers Peter and John B. Johnson, by careful work, close application and praisworthy determination to excel, further improved the overhand movement, it had not reached anything like popularity. The advent of the redoubtable 'J. B.' in his trials with the best men of London, or in

fact the world, could bring forward proved beyond any lingering doubt the superiority of the lengthened reach with the uppermost hand and arm above the surface, and since the year mentioned, the improvements made and practiced by the brothers Johnson have been adopted by the swimming world as the greatest development which has yet been attained in the history of the art."

Most swimming writers have given to William Trudgen the credit of having first used the stroke which bears his name in England. TRUDGEN not TRUDGEON, a sea-faring man, is said to have learned the stroke in the river while in Buenos Ayres, where the natives used it almost without an exception. The trudgeon stroke, as William Trudgen swam it, was not at all like the trudgeon stroke today. Trudgen swam with an extremely short-arm action, the hands entering the water almost level with the shoulders, while the legs were used in the breast stroke frog fashion. The peculiarity of this stroke was considered to be the fact that Trudgen lifted both arms from the water alternately as they were recovered for the next stroke. Thus the resistance to forward progress was still further decreased. Frank Sullivan in his work, "The Science of Swimming" describes the technique (19)
of the stroke.

"The body was held high out of the water, the head turned neither to the right nor left, and with the double overarm stroke, a single kick was used that was not a 'scissors' as

we know it now, but a combination that was part 'scissors' and part 'frog'. It was impossible to hold this stroke for any distance, as keeping the body so high out of water had a very tiring effect."

After defeating the best swimmers of England, Trudgen was surprised to learn that he had established a new record. It may be said that Trudgen demonstrated the important principle of recovering both arms free of the water and greatly increased the interest in competitive swimming. Swimmers began to experiment for faster means of propulsion. This period marks one of the greatest in all competitive swimming history. England ruled the world and developed many famous swimmers. Some of the great swimmers of England during this period were E. T. Jones, J. Nuttall, J. H. Tyers, Hellings, Derbyshire, and Lane. Their times in the 100 yard swim ranged from 60 to 75 seconds. By 1902 Lane had succeeded in swimming the 100 yards in 60 seconds flat and Derbyshire lacked one-fifth of a second of equaling it. The 440 yard records were held by Henry, Nuttall, Tyers, Jarvis, and Billington with times ranging from 6:04 to 5:28 2/5. In the 880 yard race, Ainsworth, Shoetel, Tyers, Thompson, and Jarvis were at the Top with the best record at 12:17. The mile had Davenport, Beckwith, Collier, Nuttall, and Jarvis with the best performance 24:42 3/5. To climax this great era of English swimming history, the spotlight changed to Australia where a still faster sprinting stroke was

invented, the Australian crawl, by Richard Cavill, a young Australian swimmer of Syndey, New South Wales. This story of the origin of the AUSTRALIAN CRAWL STROKE is related by Frank Sullivan.(14)

"Tums Cavill, a member of the world famous family of swimmers, was matched to meet Syd Davis at 50 yards, with legs tied, and beat him, only to be defeated later by the same man at the same distance after the legs were untied. Dick Cavill was present and refused to believe that, but a few private time trials convinced him that his brother could really sprint faster without the use of his legs, and this started him to thinking. He reasoned that every ounce of power properly applied must resolve into an increase in speed, so that the 'scissors' kick must be radically wrong. The question was to find the right one. Then he remembered having seen Alec Wickham, a fast young Rubiana sprinter use an odd straight legged kick, which he had learned from the natives at Colombo, Cylon, and decided to experiment with it. The result surprised him, as the kick proved speedy from the very first trial. Unluckily, the difficulty of finding an arm action that world harmonize bothered him considerably and by the time Dick Cavill found it, the 100 yard championship was only a few days off. He entered, however, anxious to give his find a public trial. Those who followed swimming at the time may remember the race

Starting out at a terrific pace. Cavill reached the 50 yard mark fully five yards ahead of his nearest competitor. But here the imperfectly mastered stroke began to tell upon him and he was passed by the speedy Bishop. Notwithstanding the defeat, this performance gave the coaches an estimate of the value of the new stroke (which peculiar action won for it the title of the crawl) and they took it up immediately, forming classes to teach it. Their success was marvelous. Men who had been but indifferent swimmers came to the fore, good men improved and soon the world was ringing with the news of the great work of the 'crawlers'. Al Wickham at Rubiana swam 50 yards in 24 seconds with it, and then Dick Cavill went his phenomenal 100 yards in 58 seconds. The stroke soon invaded Europe and eventually it reached America where it was taken up in 1904."

In 1902, Richard Cavill first went to England to demonstrate the Australian crawl and swam the remarkable hundred yards with it in 58 2/5 seconds. The British experts said at this time,

> "He adopted a stroke entirely new to English critics. He kept his head entirely under the water and extended his arms forward under water, his kick being a revelation to our swimmers."(19)

In 1903, in this country the Australian crawl was considered a novelty and the Trudgeon still the premier racing stroke.

The Australian crawl had to be remodelled on account of the unsuitability for the short, fresh-water tanks in which most of the swimming in the eastern United States was performed. Thus, a modification of the Australian crawl produced the AMERICAN CRAWL STROKE. Some of the Australians called the Americans pilferers because it seemed that we had taken their stroke, modified it a little, and then called it by an American name. The early development of the stroke in the country is described by C. M. Daniels, (4) the great American swimmer, as follows:

"Mr. Gus Sundstrom, instructor at the New York Athletic Club, was indirectly responsible for the introduction of a stroke called the 'Swordfish Stroke' in which the body was propelled through the water by a continuous drive of the legs. He has more leg drive alone than any man I have ever seen, not only bends the ankles back and forth, but says that it is by doing it that he gets his wonderful speed. A few of the American swimmers move their ankles a little, but most of them keep them rigid. A few Americans have adopted the Australian stroke with its wide and synchronous thrash, but have added a fluttering of the feet which makes the action continuous. With the exceptions of few, the arms and legs are worked independently and the thrash has a narrower scope, the legs being opened less."

It may be said that Daniels studied the crawl stroke of the Australians at Athens in 1906 when he saw Cecil Healey

use it. He practiced it assiduously at home and perfected a style entirely his own.

While Cavill in Australia succeeded in making 100 yards in the phenomenal time of 58 seconds flat; and another Australian, Healey, duplicated the feat the succeeding year, Daniels eclipsed both of these records with times of 57 2/5 seconds (Richmond, England, 1906), 65 seconds (St. Louis, 1906), and finally 55 2/5 seconds (Manchester, England, 1907). Daniels became one of the greatest speed swimmers the world has ever known. His book (4) written with the assistance of L. de B. Handley and Otto Wahle, remains one of the most authoritative regarding the early development of the crawl in the United States.

By 1907 the American stroke had become the premier racing stroke of the world. At the London olympics, in 1908, Daniels and Hebner clearly demonstrated the superiority of the American stroke. Since that time the Australian stroke has been obsolete.

At races of longer distances, Barney Kieran, of Australia, was successful with still a different style known as the AUBLE CRAWL which emphasized the roll, allowed breathing on both sides and changed the timing of the leg kick so that it came simultaneously with the armstroke of the same side.

After Daniels, the great American swimmer, was Duke

Kahanamoku, the Hawaiian, who succeeded in still further lowering the 100 yard world's record. In 1913 he lowered Daniel's record to 54 2/5 seconds, and in 1915 to 53.1 seconds, and again in 1917 to 53 seconds flat. The Duke used the American crawl with a very fast and vigorous leg drive of continuous action. Hence his arms were thrust in rather close to his head.

Some of the American Coaches were reluctant to give up the wide scissors kick of the trudgeon stroke. Sullivan experimented with a stroke which combined the features of the trudgeon and the crawl. The stroke became known as the TRUDGEON-CRAWL and was characterized by a series of flutter kicks added to the wide major kick of the trudgeon. Later this merged into the type as used by Daniels because, when the wide kick was used on both sides with the small flutters between, it became the DOUBLE TRUDGEON-CRAWL. THIS STROKE is a balanced stroke of six beats to the arm cycle and is the same as the American crawl.

L. de B. Handley (10) writes:

"Some eight or nine years ago, Frank Sullivan, one of Chicago's leading instructors, conceived the idea of combining with the crawl some of the features of the trudgeon and make it useful for distances greater than 100 yards."

At this time there was great confusion because of the many types of crawl strokes. Daniels is quoted again:

"There are as many varieties of the crawl nowadays

as there are men using it. No two men swim it alike and each indulges in a little experimenting of his own. This will gradually lead to progress, and it is probable that as the men discard the inefficient details in favor of the more efficient ones, the different varieties will condense into different strokes from which the best will eventually be picked."

A "Symposium of the Crawl Stroke" was edited by F. W. Luehring and printed in the Intercollegiate Swimming Guide (14) in which the opinions of Handley, Hendman, Kistler, Langer, MacKensie, Manley, Mann, Nelligan, Sullivan, Whitaker, and White are given on many important points of crawl technique.

The results showed a wide divergence of opinion:

"At the present time, there are at least ten different styles of the crawl, each having a large following. There is only one question which the American coaches agree on and that is, that the original crawl or Australian crawl is obsolete today. The American crawl of four, six or eight beats has proved so successful that the Australian, German, and English swimmers are endeavoring to master the intricacies of the American stroke." (SULLIVAN)

"Our ideas that the Australian swimmers swim their crawl to a timing system is all paper talk. The only difference is that they swim with a shade wider armstroke in entering the water, otherwise they are about the same as we are, but probably use more leg work from the knees down than

we do. Duke Kahanamoku, whom I trained for six months, used an independent action." (KISTLER)

"The American standard accepted today is the six beat trudgeon-crawl. Results in national and international competition have furnished convincing proof of the supremacy of the American crawl, so there can be no question concerning the advisability of adopting it." (L. de B. HANDLEY)

The past few years have brought remarkable performances with the crawl stroke. It is not only being used over the short sprint distances, but over the longer swims, even the marathon swims of 10 or more miles. Exponents of the American crawl have competely eclipsed all records set with other strokes and defeated conclusively devotees of the latter over the long marathon swims for which no records can be set owing to varying conditions. The greatest feats of combined speed and endurance ever accomplished stand to the credit of swimmers affecting the American type of crawl. Mr. L. de B. Handley, (9) the coach of the New York Women's Swimming Association, has written several popular articles and some excellent books in which he portrays the great advantage of crawl swimming to the complete satisfaction of crawl devotees.

Possibly the greatest swimmer of all times is Johnny Weismuller, who started breaking records in 1922 and has continued on the greatest record onslaught of any known swimmer. In 1923 he succeeded in breaking the Duke's 100 yard record

which stood for so many years. He has held more than 50 world's records at all distances up to and including the 880 yard swim. Under William Bachrach, coach of the Illinois Athletic Club, Weismuller has astounded the world with his succession of brilliant performances. In the 1926 handbook of the National Collegiate Athletic Association, Coach Bachrach gives an analysis of Weismuller's crawl. There is no doubt that Weismuller had one a great deal to stabilize the standards of the stroke and to encourage wholesale participation in speed swimming.

The Americans have been victorious regularly since the 1908 olympics except the 1932 games in international competition. The coaches, the schools, the colleges, and clubs are developing thousands of excellent performers in crawl swimming. One of the most important developments has been that of the place women and girls have come to occupy in the realm of swimming competition. In 1920 the International Amateur Athletic Federation recognized and established competitive swimming for women as a permanent feature of the world of sport. Undoubtedly, the selection of a team of twelve girls to represent the United States at the olympic games at Antwerp in 1920 and their subsequent victories established amateur swimming for women in this country as a permanent sport. The performances of girls, who in many cases were children of 10-14 years of age, were almost beyond belief compared to the records made previous to 1900.

Girls are actually eclipsing the best records made by men at that ti e. Those who have witnessed some of the extraordinary performances of some girls like Virginia Whitnack, Sybil Bauer, Josephine McKim, Gertrude Ederle, Aileen Riggin, Helen Wa'nright, Eleanor Holm, Albina Osipowich, Martha Norelius, Ethel Lackie, Eleanor Garatte, Adelaid Lambert, and Helene Madison marvel at their ability.

Still again, the crawl stroke has been modified. Many contestants, particularly girls, have introduced a still faster kick with eight, ten, and twelve beats per arm cycle. After developing the kick separately, some individuals fall into a faster rhythm naturally which is combined with the armstroke. In this type of kick, extraordinary control is necessary, but the kick may actually take less strength to perform than the six beat crawl.

Since July the Japanese have taken the spotlight of swimming away from the Americans. With a team of excellent swimmers, the Japanese have modified the crawl still further and made another step in the history of swimming. They have added a peculiar action and body lean that with their structures physically helps them through the water.

Nevertheless, with a rather noticeable stabilization of the crawl as the premier racing stroke of the world, speed swimming has come to the front with leaps and bounds. Already in some of our colleges it has become a major sport.

As an outgrowth of its popularity, relay swimming has become the expression of mass participation. This is typified by the mile relay event in which seventeen swimmers negotiate 100 yards each and the last 60 yards. The Yale team holds this mass accomplishmont record at this time with 16 minute 53 and 2/5 seconds, an average of 57.5 seconds for each of the first seventeen men per one hundred yards. When this performance is compared with the listed records of 100 yards by Cavill, the significant growth of swimming as a competition sport becomes apparent.

A SURVEY OF THE LITERATURE OF SWIMMING

In the beginning it may be said that the point of view in making this study of the literature is from the standpoint of swimming as an efficient means of locomotion. An endeavor is made to outline steps of progress and to quote the leading contributors in the advance of knowledge. No attempt is made to cover all the literature pertaining to teaching methods of beginning swimming. Efficient locomotion means expediency in covering the distance between two points, hence speed.

History of testing in Swimming.

About seven decades ago, swimming began to attract the attention of some investigators in the scientific field but the early works were mainly concerned with swimming as it occurred among the marine animals. One work before this time seems of some worth, namely, that of Borelle, the famous Italian scientist. His work "DeMotu Animalium," in two volumes, was published in Rome in 1680. The impetus for the study of marine animals was received apparently from the demands in ship building industry in the hope of designing more efficient craft.

1883. The book "The Swimming Instructor" by William Wilson is a very important one and contains much valuable information. Wilson complains in general about the slowness of swimming but explains that the instructors seem helpless

to improve the situation. He is also remembered as the inventor of water polo.

1914. At the International Y. M. C. A. College, Springfield, Massachusetts, there are four pioneer theses completed in 1914 having to do with scientific study of some physiological problem in swimming. Wellington (21) and Pritchard studied the influence of swimming on body weight and temperature. Their general conclusions were that there is practically no loss in weight in swimming distances under 440 yards.

Schultz (18) completed a thesis comparing the changes in blood pressure while swimming with changes during running. His general conclusion is to show that the increase in pressure in swimming is only 87% of that of running (100 yard dahses) and 67% of running in longer distances (440 yards).

Wielt (20) completed a thesis showing the effect upon heart rate in swimming and also made comparisons with running. His general conclusion is to show that the influence on the heart rate is less in both the 100 and 440 yard swims than in the same distances running, indicating that swimming is not so strenuous as running as far as the heart action is concerned.

1919. Lyon (16) completed a thesis also, in which the quantitative and qualitative analysis of albumen concerned the urine after swimming. His conclusions show that competitive swimming causes as much albumen to appear as does

a full game of basketball, football or soccer.

1927. Brown,(1) in his thesis of 1927 studied the effect upon the heart rate of submerging the body, bobbing, and the hot shower. His conclusion is that cold water slows the heart rate; bobbing was effective in bringing the heart back to normal faster than ordinary breathing; and that the hot shower delayed the return of the heart to normal but prevented shivering.

1930. Cureton, T. K. Jr.(2) in his thesis of 1930 studied the various phases of placement testing, structural and functional requirements of competitive swimming, physics of swimming and some physiological relationship. Cureton has done outstanding work and stands out as the foremost tester of swimming in the United States today.

There is not to be found any scientific work showing the distribution of swimming ability among diversified or homogenous groups. Normal scales for objective grading of the efficiency of the performance in terms of speed are not available. The correlation between different types of swimming in the same individual have not been established.

There is nothing in the literature showing the correlation between structural and functional characteristics of the individual and efficient speed swimming performance.

Until the studies this year which are contained in this thesis, there have been no published study showing how a

coach may objectively test competitors to determine their ability and progress.

There has not been enough study and research to compare swimming with other sports thoroughly. The benefits of swimming are reputed to be many, and they undoubtedly are, but a quantitative comparison is impossible at the present time.

THE MATERIALS AND METHODS USED IN THE EXPERIMENT

My experiment divided the participants into two groups:

1). An experimental group consisting of members of the Amherst High School physical education class who took swimming at the Massachusetts State College pool. This group consisted of fifteen members.

2). A control group of fifteen members of varied swimming ability chosen from the student body at Massachusetts State College.

With the development of a combination of tests which when applied might prove an index to swimming ability, I have taken into consideration the following points:

1). The tests should be simple to administer so directions can easily be followed.

2). The tests must be easy to score in objective units so that no personal judgment is involved.

3). The tests must be valid, that is, they must measure what they purport to measure.

4). The battery must be one which can be given in a short time and involve no complicated set-ups or apparatus.

The tests to be used are six tests of specific ability in swimming.

1). Leg movement test.

2). Arm Movement Test.

3). Breathing test.

4). Speed test.

5). Co-ordination test.

6). Endurance test.

In order to have a complete understanding only of fundamentals in swimming, each test has been made to test as true as possible, and at the same time, to make each truly objective and verifiable.

These following six tests measure only individual skill with no attempt to consider other relationships:

TEST ONE - The Leg Movement Test

This test is designed to measure the ability to manipulate the feet in the flutter kick using a flutter board. The subject starts with the board in front of him and uses his legs only for the distance of the tank. Time to be taken from the second he leaves the end of the pool and to be stopped when the board touches pool at the other end with the subject using the flutter kick. Time to be scored in tenths of seconds.

TEST TWO - The Arm Movement Test

This test is constructed to measure the ability of the subject to swim using the correct arm action of the crawl without the aid of his feet. The watch to be started when subject leaves the starting line which in this instance

will be the end of the pool. He will swim as far as he can and the distance and time will be kept. One length of the tank will be considered the maximun distance. (To aid measurements, an inflated auto tire tube is used for the feet to avoid possible movement).

TEST THREE - The Breathing Test

Breathing is a fundamental that all swimmers must master. This is a test to measure the ability of the subject in breathing. This event will be performed in the deep end of the pool. The subject will jump in the water at the side of the pool and cross the pool using at least 10 "bobs" to make the crossing. The subject will strike his feet on the bottom at the downward end of each bob, and raise his hands out of the water at the upward end of each "bob," and exhale through the nose when under water and inhale through the mouth when out of the water on each "bob," time to be scored in tenths of seconds.

TEST FOUR - The Speed Test

This test is developed to test the subject's ability to attain speed under controlled directions. The subject is urged to go as fast as possible but to keep in the designed lane and swim from one corner of the pool down to the other end, turn and swim across the width, make another turn swim the long length keeping in lane, and then finally return to starting corner. Time to start on the word "go" and to be stopped upon his touching the gutter at the start-

ing side. Time to be scored in tenths of seconds.

TEST FIVE - The Co-ordination Test

This test is constructed to measure the subject's ability to co-ordinate his body in swimming. He must use arms, legs, correct breathing, follow a designated direction, turn, and repeat his procedure.

The subject will start from a position of immersion in the water at the side of the pool, facing out, one hand on the gutter and the other extending forward on the surface of the water, and the feet drawn up under the body placed against the wall. The subject will then release his grip in gutter and swim to opposite side using legs, arms, and breathing. Then he will make correct turn and follow back in the same manner. This will be repeated for 10 crossings. Time will be kept from moment of release of gutter by hand until hand touches the side of pool at the completion of tenth crossing. Time to be scored in tenths of seconds.

TEST SIX - The Endurance Test

This test is constructed to determine the efficiency of the subject in working under fatiguing conditions. The subject is required to swim up and down the length of the pool just as long as he possibly can or has reached the maximum distance of 440 yards. Time to be scored as usual but swimmers dropping out sooner will score points only in complete 10 yards of swimming. Points to be given on the

basis of one for each 10 yards completed.

THE METHOD OF PROCEDURE

At the beginning of the experiment, the above tests were given to the control group and experimental group at approximately the same time. After eight weeks of instruction of forty minutes twice a week and two weeks of actual swimming as a recreational and personal improvement period, the experimental group was again tested to determine whether or not any progress had been made in motor skill. Also at this time, the control group was again tested to see whether or not any progress had been made in this group which had not been instructed. This group was used primarily in the various tests to determine the validity of the particular test.

The raw scores of each test were properly placed to make all scores comparable in relation to the other students of each group.

In the experimental group, during the period of instruction, the following plan of procedure was used:

FIRST MEETING: (First Week)

1). Describe arm stroke, standing (5 minutes).

2). Land Drill on arms (10 minutes).

3). Arms in water--feet hooked in gutter (15 minutes).

SECOND MEETING: (First Week)

1). Review previous lessons (10 minutes).

2). Land drill with arms (5 minutes).

3). Practice arms across tank (15 minutes).

THIRD MEETING: (Second Week)

1). Review previous lesson (10 minutes).

2). Practice arms across tank (5 minutes).

3). Practice and Demonstration of Bobbing (5 minutes).

4). Demonstration of use of legs (5 minutes).

5). Free practice period (5 minutes).

FOURTH MEETING: (Second Week)

1). General Swimming Period (10 minutes).

2). Describe land drill with legs, and practice (15 minutes).

3). Describe leg drill from side of pool and practice (15 minutes).

FIFTH MEETING: (Third Week)

1). General Swimming Practice Period (10 minutes).

2). Land drill of legs (10 minutes).

3). Leg drill from side of pool and practice (10 minutes).

4). Legs only across pool (10 minutes).

SIX MEETING: (Third Week)

1). General Swimming Practice Period (10 minutes).

2). Land drill of legs (5 minutes).

3). Leg drill from side of pool and practice (5 minutes).

4). Legs only across pool with bobbing at intervals (15 minutes).

5). Arms only across the pool (5 minutes).

SEVENTH MEETING: (Fourth Week)

1). General Swimming Practice Period (10 minutes).

2). Practice bobbing (5 minutes).

3). Explanation and demonstration of arms and legs co-ordinated (10 minutes).

4). Arms and legs across the pool (15 minutes).

EIGHTH MEETING: (Fourth Week)

1). General Swimming Practice Period (10 minutes).

2). Explain correct breathing (5 minutes).

3). Practice bobbing (5 minutes).

4). Practice arms and legs (10 minutes).

5). Practice arms and legs and breathing (10 minutes).

NINTH MEETING: (Fifth Week)

1). General Swimming Practice Period (10 minutes).

2). Practice complete stroke (20 minutes).

3). Review worse skill, at will (10 minutes).

TENTH MEETING: (Fifth Week)

1). General Swimming Practice Period (10 minutes).

2). Swim around pool - full stroke (10 minutes).

3). Explain turns (5 minutes).

4). Practice turns across pool - swimming (15 minutes).

ELEVENTH MEETING: (Sixth Week)

1). General Swimming Practice Period (10 minutes).

2). Individual free period (30 minutes).

TWELFTH MEETING: (Sixth Week)

1). General Swimming Practice Period (10 minutes).

2). Practice complete stroke (30 minutes).

THIRTEENTH MEETING: (Seventh Week)

1). General Swimming Practice Period (10 minutes).

2). Individual instruction in noted weaknesses for all (30 minutes).

FOURTEENTH MEETING: (Seventh Week)

1). General swimming Practice Period (10 minutes).

2). Individual instruction in weaknesses (30 minutes).

FIFTEENTH MEETING: (Eighth Week)

1). General Swimming Period (10 minutes).

2). Swim 23 to 50 yards using correct stroke (30 minutes).

SIXTEENTH MEETING: (Eighth Week)

1). General Practice Period (10 minutes).

2). Practice any event (30 minutes).

SEVENTEENTH MEETING: (Ninth Week)

1). Free period (40 minutes).

EIGHTEENTH MEETING: (Ninth Week)

1). Free period (40 minutes).

NINTEENTH MEETING: (Tenth Week)

1). Free period (40 minutes).

TWENTIETH MEETING: (Tenth Week)

1). Free period (40 minutes).

(The general practice period which was assigned at the beginning of each session was purposely allowed because of stragglers coming in late and as a recreational period which the students were entitled to on account of this work being voluntary on their part.

INTERPRETATION OF DATA

Data were collected from fifteen of the experimental group and a similar number of the controlled group. All the subjects experienced this testing in the named groups and added data for this experiment. However, when the data were evaluated, it was found that in the experimental group one entire case had to be discarded due to incompleteness caused by periodic absence and sickness. There were also portions not recorded because of insufficient data to warrant addition to the test.

In the controlled group, the number of incomplete cases reached a higher toll. Six members had to be dropped because of various reasons not bearing directly with the experiment.

Results have been tabulated in raw scores and consequently show each group's actual objective test units. For the clearness of the reader, all units have been carefully placed in tables showing the individual and group average of each test. The first time taken has been spoken of as the pre-test time. Likewise after instruction, the term applied has been post-test time. In all the following tables, the same alphabetical or numerical order is uniform throughout. The graphs following each table have been arranged according to the greatest differences in time range showing pre-test time and post time scores of each individual.

Just as reiteration, the writer wants to again make clear, before the reader, that his interest in the problem centers around a means of determining the progress of an individual in the learning of specific motor skills, and to develop a combination of tests which when applied might prove an index of swimming ability.

Therefore with these two thoughts in mind, the writer's study concerned (1) Can a series of tests be developed to measure progress in swimming? (2) Then using the same tests, can they be used as a means of predicting potential swimming ability?

With such a task before the writer, the data of the experimental group are of vital importance and primarily essential for interpretation of the data.

As shown by the chart, a glance tells one that many complicated and untold elements, all too numerous, have entered into individuals. The writer has tried to avoid as many as possible and has allowed the "stop watch" to do the recording and thus do away with subjective matters as much as possible.

Physical Education, with a definite aim, can aid greatly in bettering individual performances. As mentioned, most physical education classes are neglected in the manner of development and resolved to gather all they can by any means

possible. Thus to purport the contention, many isolated and group cases will be shown whereby just this idea can be remedied.

The writer seized the opportunity to experiment and by aid was able to secure a group for his purpose.

Immediately the tests were started and a precaution was taken to allow each subject ample time between tests so that physical efficiency or personal condition went uninjured.

Therefore with all data recorded, one can start with the first test and ascertain without subjective matters all conditions of the problem.

Showing Experimental Group Test Data

Name		Leg Test	Arm Test	Breathing	Speed Test	Co-ordination	Endurance
A	Pre	1:11.3	29.3	8 22.3	1:07	1:42.4	9:46.2
	Post	1:12.1	30.6	10 22.7	58.6	1:27	8:29.4
B	Pre	1:07.1	24.4	4 10 10.2	1:28	1:28.2	7:06.4
	Post	59.1	23.1	37.8	60.1	1:24.4	7:23.5
C	Pre	28.5	49.8	4 10 12.5	1:13.6	1:13.6	9:43.8
	Post	27.1	25.	29.5	1:08.3	1:41.1	9:58.3
D	Pre	36	21	10 10 40.5	56.5	1:31.5	8:93.2
	Post	34.1	21.4	23.	53.2	1:30.1	8:12.1
E	Pre	29.7	25.8	9 10 22.4	47.6	1:31.2	8:37.4
	Post	28.6	26.3	23.3	47.7	1:25.3	8:29.6
F	Pre	37.5	24.8	10 35.4	56.7	1:27.5	8:58
	Post	31.2	26.4	10 27.8	60.6	1:33.3	8:51.2
G	Pre	36.1	29.6		1:13.5	1:37.8	100 3 13.4
	Post	32.5	30		1:12.1	1:53.3	50 2.28
H	Pre	1:20.6	25.3	7 30.2	1:06	1:40	250 6:02.5
	Post	1:03.4	21.4	10 24.4	1:10.3	1:47.5	9:06
I	Pre	1:33.2	30	2 8.5	1:03.6	1:44.3	10.38
	Post	1:17.1	29.3	10 23.6	1:11.9	2:02.3	10:16.7
J	Pre	57	25.6	2 5.7	1:03.4	1:47.7	8:40
	Post	45	26.7	10 31.4	1:06.7	1:47.2	8:27.2
K	Pre	40.7	25.3	7 22.8	1:02.5	1:30.4	9:04.5
	Post	45.7	25.	10 22.3	1:31.6	1:02.3	8:29.2
L	Pre	28.4	29.4	10 38.6	1:91.3	1:28.7	8:04.1
	Post	25.4	27	10 31.1	54.5	1:20.3	7:52.1
M	Pre	1:29.7	35.6	10 35.3	1:21.2	1:58.6	10:15.2
	Post	1:12.4	29.8	10 26.6	1:16.6	1:51.3	10:01.1
N	Pre	36.8			1 length		
	Post	31.2			33.3		

LEG TEST OF EXPERIMENTAL GROUP

In test one, the leg test, the experimental group had a total progress of 10.83%. Here the pre-test time of 52.3 seconds as a group average appears as the starting for this experimental group. Upon the completion of the allotted instruction period, the class average was lowered to 46 seconds.

Individuals varied in the amount of progress and each can be seen by Table I to really o fer one a definite example.

For brevity and the sake of definiteness, it is impossible to narrate each case separately but as an example of future predictability, the greatest gain and loss in each test will be attempted to offer a possible clue to an explanation. All the personal traits in instruction are needed and with observational notes, some can be accounted for rather justly.

In this experimental group, 21.26% is the largest gain. It can readily be seen that adaptive and constructive motor habits in this skill, shown with the slow time, have aided in lowering the time. The post-time is still far from average, but at least the subject has started on the correct track and with more practice can still lower and better his time.

The largest single loss is 12.28%. It is hardly just to assume subjective elements but the subject, as noted, has shown to be rather complicated due to his indifferent attitude. This boy has ability and could really improve more than others but lacks personal interest to raise his level and so remains a problem. To accuse the student in harsh terms would be ruining matters as the work has been voluntary to them and so an occasional spasmodic relapse can be readily noticed. Consequently with such objective units and grades to be made, a boy of this type would be inclined otherwise because in the presence of others, he failed.

It is essential, in passing, to remark that the leg test has produced satisfactory results in general and immediately warrants a place in the series of tests designed by the writer.

TABLE I

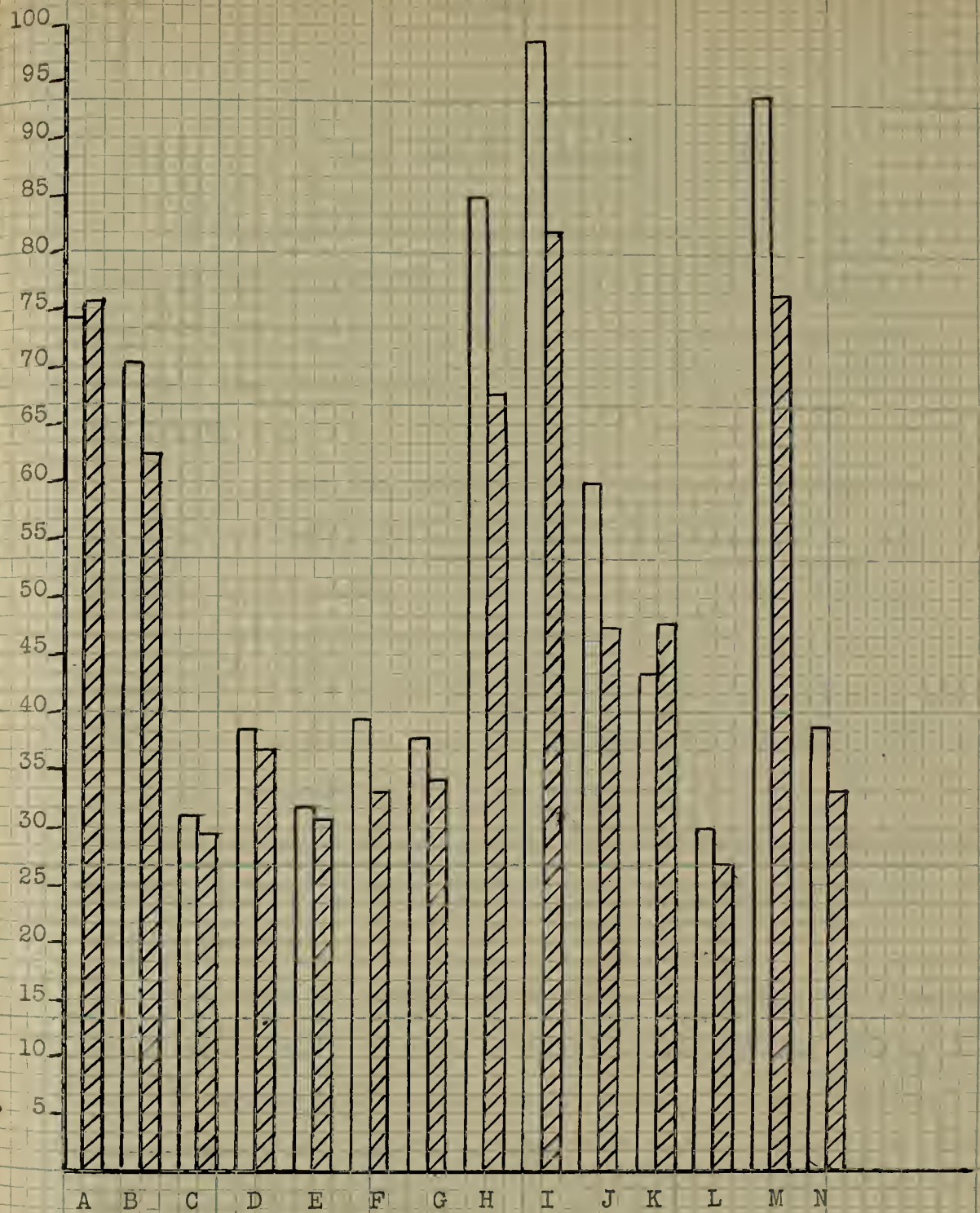
Showing Leg Test Progress of Experimental Group

Name	Pre-test Time	Post-test Time	Gain or Loss	
A	1:11.3	1:12.1	-.8 sec.	-1.12%
B	1:07.1	59.1	8.0	11.92
C	28.5	27.1	1.4	4.91
D	36	34.1	1.9	5.27
E	29.7	28.6	1.1	3.70
F	37.5	31.2	6.3	16.80
G	36.1	32.5	3.6	9.97
H	1:20.6	1:03.4	17.2	21.26
I	1:33.2	1:17.1	16.1	17.26
J	57.	45.	12.	21.05
K	40.7	45.7	-5.	-12.28
L	28.4	25.4	3.	10.56
M	1:29.7	1:12.4	17.3	19.29
N	36.8	31.2	5.6	15.22
Total	732.6 sec.	644.9 sec.	87.7 sec.	10.83
Average	52.3	46.		

Largest Gain 21.26%
Largest Loss 12.28%

Graph I

Leg Test of Experimental Group



ARM TEST OF EXPERIMENTAL GROUP

Closer analysis of test two, the arm test, shows that the group average in the pre-test time was 28.9 seconds. The post-test time was 26.3 seconds and thus calculating the average of the group progress, it amounts to 9.05%.

Here again the unusually large gain of 49.79% came from a very small individual who had a remarkable leg action, in fact, the second best in the group. He was very individual in his arm action and only used them as appendages for keeping himself afloat and relied upon his legs for propulsion. Almost immediately one could see his need for instruction in arms more than in legs. As a result, he spent considerable time during practice periods working on the correct arm action and his results speak highly for him.

The loss of 6.49% came from an individual who appeared physically "off" as used in physical education. His ability is not hampered but shows him as highly too anxious and consequently all of his attempts to prove better have left him slower than before.

This test has given the writer some trying moments. An inflated auto tire tube has slowed the times of all. Some subjects found real difficulty in keeping the tube

under their feet and lost many seconds in the test. Adherence, however, is justifiable but only because it measures what it purports and omits factors such as leg movement and unconscious kicking. Therefore even in the face of slower time and slowness in starting, this test measures one of the most essential fundamentals of swimming.

TABLE II

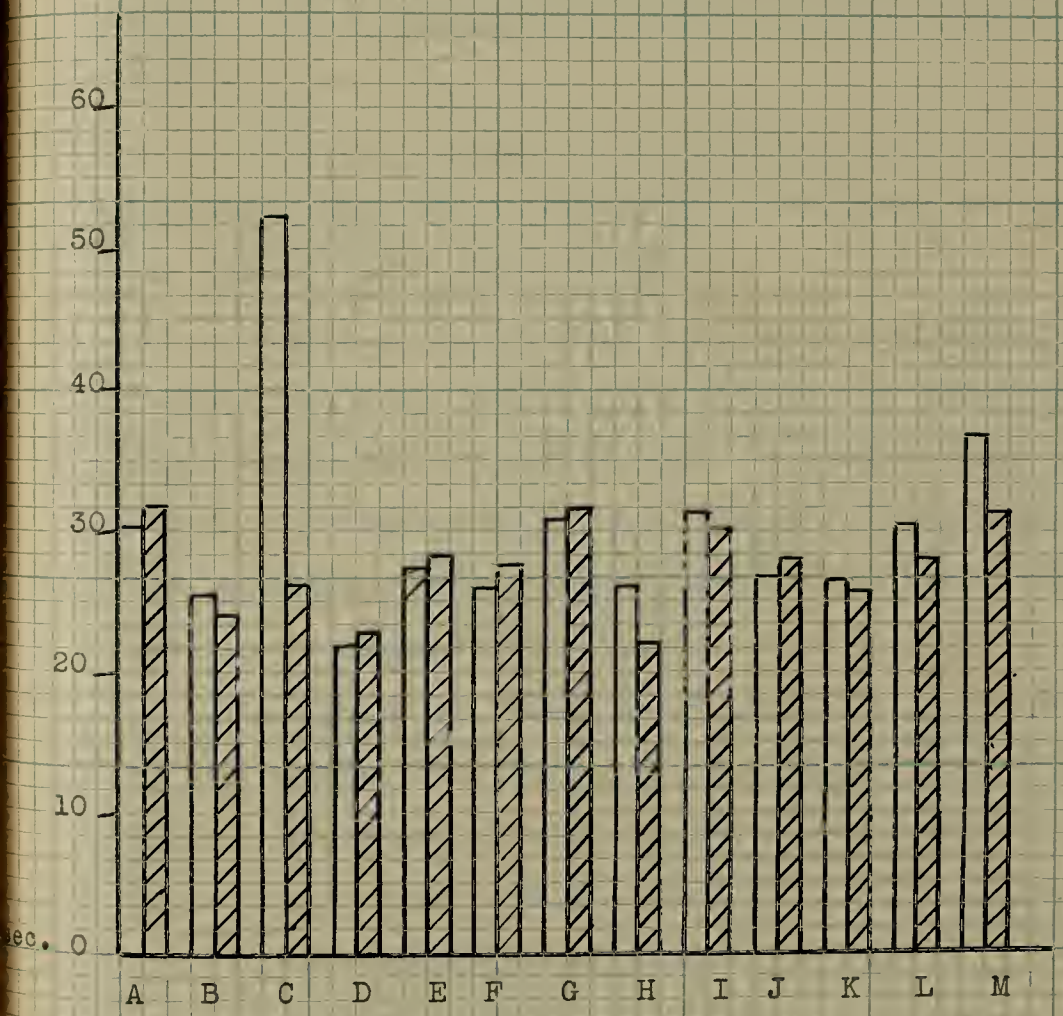
Showing Arm Test Progress of Experimental Group

Name	Pre-test Time	Post-test Time	Gain or Loss	
A	29.3	30.6	-.7 sec.	-2.39%
B	24.4	23.1	1.3	5.32
C	49.8	25.	24.8	49.79
D	21.	21.4	-.4	-1.90
E	25.8	26.3	-.5	-1.93
F	24.8	26.4	-1.6	-6.49
G	29.6	30.	-.4	- 1.37
H	25.3	21.4	3.9	15.41
I	30	29.3	.7	2.33
J	25.6	26.7	- .9	- 3.51
K	25.3	25.	.3	1.18
L	29.4	27.	2.4	8.16
M	36. 5	29.8	5.8	16.29
N				
Total	375.9 sec.	342. sec.	33.9 sec.	9.05
Average	28.9	26.3		

Largest Gain 49.79%

Largest Loss 6.49%

Graph II Arm Test of Experimental Group



BREATHING TEST OF EXPERIMENTAL GROUP

The breathing test as it is mentioned previously is to aid the swimmer in one of the greatest essentials of swimming. It is surprising to note who many can swim fairly well but have no conception of breathing in the water. As a result, this test can aid gre tly in the series.

"Bobbing" approaches the nearest single skill of breathing that can be described. The group was exposed and showed their exact breathing.

As most of them varied greatly in the number of "bobs," the time for each was figured out and recorded. The average time in pre-testing was 3.42 seconds per "bob". The same conditions existing but ten weeks later, the same group averaged 2.69 seconds per "bob". Thus showing an increase of 21.24%.

The number of "bobs" is a lesser item. Repetition is the only evident factor after once a subject gets the knack. Therefore, having recorded and tabulated all in Table III, one can see for himself the exact data.

It is now fitting after such a progress to include this test along with the first two.

Further detail concerning great gains or losses can be referred to the table as most every one remained near

metical trickery owing to the number of "bobs".

As a result, with such satisfactory results, one cannot omit so vital a fundamental in the series after obtaining such progress.

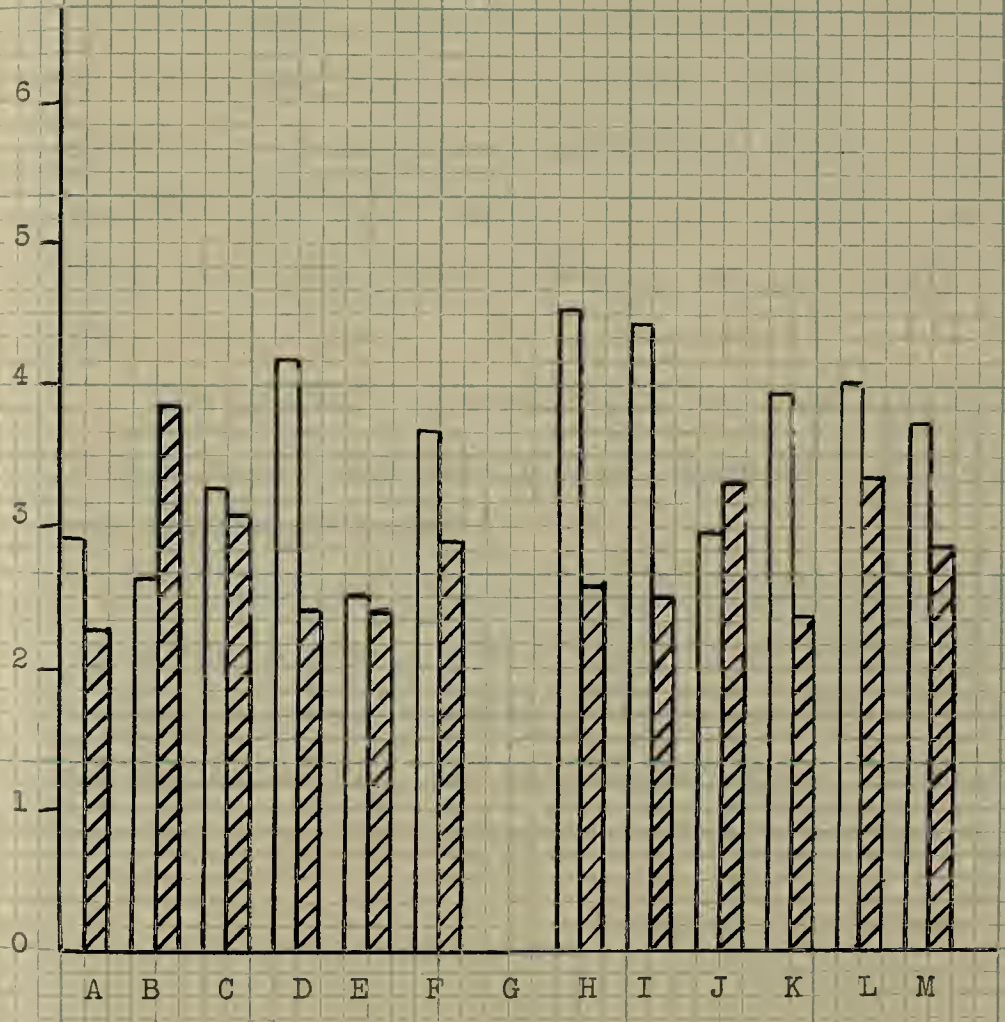
TABLE III

Showing Breathing Test Progress in Bobbing

Name	Pre-test 1 bob	Post-test 1 bob	Gain or Loss		Pre-test No. of Bobs	Post-Test	Gain	
A	2.78	2.27	.51	27.17%	8	10	2	25%
B	2.55	3.78	-1.23	-28.23	4	10	6	125
C	3.12	2.95	.17	5.44	4	10	6	125
D	4.05	2.30	1.65	40.74	10	10	0	0
E	2.48	2.33	.15	6.45	9	10	1	11.11
F	3.54	2.78	.76	21.46	10	10	0	0
G								
H	4.31	2.44	1.87	41.06	7	10	3	37.50
I	4.25	2.36	1.89	44.47	2	10	8	400
J	2.85	3.14	- 29	-10.18	2	10	8	400
K	3.74	2.23	1.51	40.68	7	10	3	37.50
L	3.86	3.11	.65	16.89	10	10	0	0
M	3.53	2.66	.87	24.33	10	10	0	0
Average of Class			$\frac{41.06}{12} = \frac{32.35}{12}$					
Pre-test	3.42	2.69	.73	21.34	83	120	37	44.57

Average of Time of Bobs 21.34%
Highest Progress 44.57% in time of ea. bob
Highest Progress in No. 400% in no.

Graph III Breathing Test of Experimental Group



SPEED TEST OF EXPERIMENTAL GROUP

The speed test as purported orginally has been a weak test. But before stating any reasons, the results will show the effects.

The class average in pre-test time was 66.22 seconds or one minute, six and two tenths seconds. The post-test time was 63.2 seconds or one minute, three and two tenths seconds. The total average of gain in this test was 4.53% which is possibly unsatisfactory with the group totals so far.

The greatest gain of 22.84% was made by a subject with endurance and therefore able to maintain a high speed over the designated course.

The greatest loss of 13.05% appeared as a very big upset especially in this test because the individual scoring had been very successful so far and here and on the co-ordination test had lost considerably. In fact, an account is hard to understand and therefore lacking.

SPEED TEST PROGRESS

Now for the writer's objections to this test in the series.

1). It is too long for a just speed test under the conditions.

2). It is very impractical to swim to the other end of the tank and make a turn very satisfactorily for a push in the new direction.

3). The measurements of this test involve more than just speed - such as turns impractical in swimming that are utterly useless.

4). No real advantage can be actually performed in this test and so another function must be substituted.

With this test highly impractical, the writer would like to state that possibly a more reasonable and practical test to be substituted for future research should consist of a speed test that measures the same designated skill but namely consists of one length of the pool with a swimming start.

After all, it is only an experiment so errors made here can add materially in future research. As nothing definite is available elsewhere, at least this is an effort in the correct direction.

TABLE IV

Showing Speed Test Progress

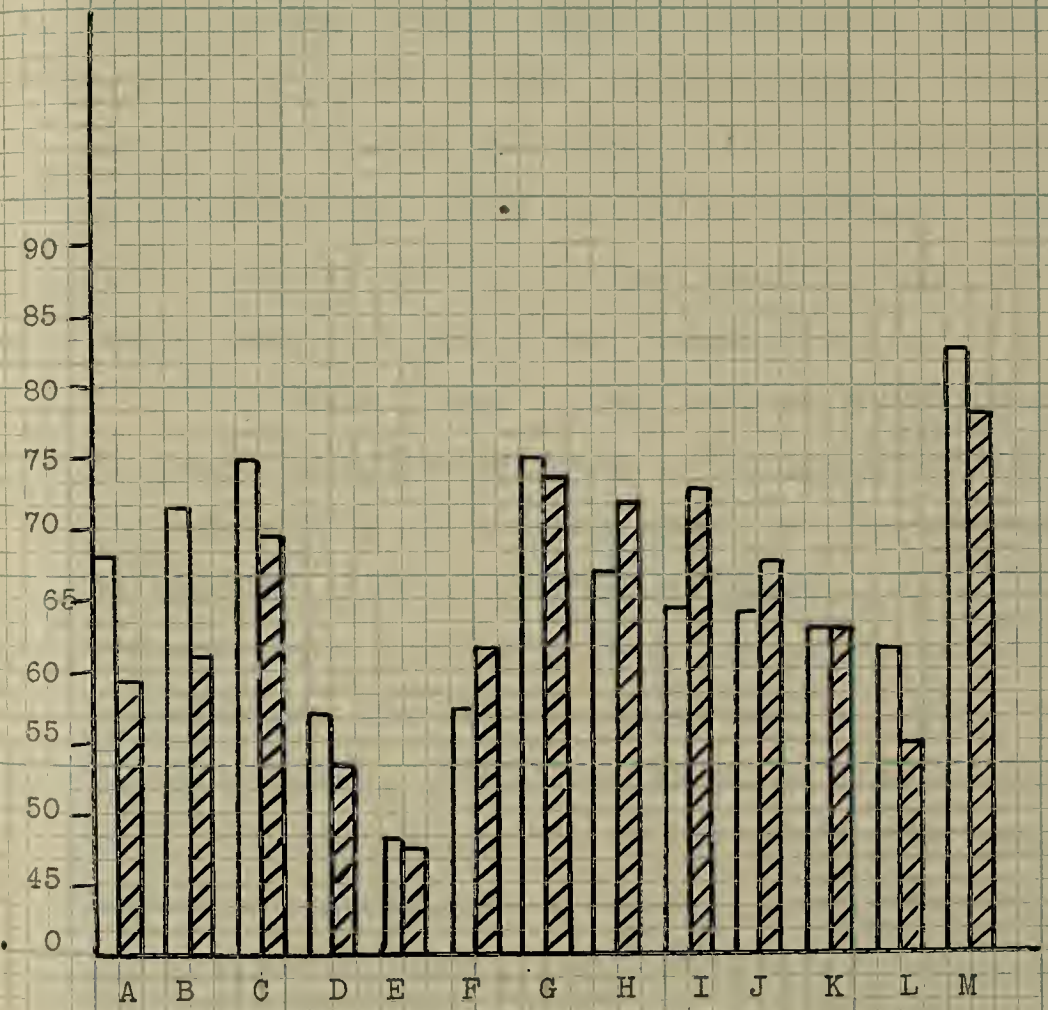
Name	Pre-test Time	Post-test Time	Gain or Loss	
A	1:07	58.6	8.4 sec.	12.53%
B	1:28	60.1	20.1	22.84
C	1:13.6	1: 08.3	5.3	7.20
D	56.5	53.2	3.3	5.84
E	47.6	47.7	- .1	- .20
F	56.7	60.6	-3 .9	- 6.08
G	1:13.5	1:12.1	1.4	1.09
H	1:06	1:10.3	- 4. 3	- 6.60
I	1:03.6	1:11.9	- 8. 3	- 13.05
J	1:03.4	1:06.7	- 3. 3	- 5.20
K	1:02.5	1:02.3	. 2	9.32
L	1:01.3	54.5	6.8	11.09
M	1:21.2	1:16.6	4.6	5.66
Average	860.9 sec.	821.9 sec.	39 sec.	4.53

Highest Gain 22.84%

Average time:-

	66.22	63.2	4.53%

Graph IV Speed Test of Experimental Group



CO-ORDINATION TEST OF EXPERIMENTAL GROUP

The co-ordination test produced results that to the writer were not at all surprising. The class average at pre-testing was one minute thirty-seven and four tenths seconds. The post-test time was one minute and thirty-eight seconds showing a loss of .7% for the group.

In this type of test, it is actually a 100 yard swim and to clip five or six seconds off the first time is good enough for such a short time in an experiment. Even then more than half the class gained considerably. The largest single gain of 9.45% is very outstanding.

When there is such a great loss as 17.25%, there must be something radically wrong. This youngster without any correct methods did a fairly good time, so with his time so high, he appeared destined to improve. But contrarily, he worked hard for the correct form and style which to him was strange. The lad is very serious and intent on doing as most students of that nature and so when he took his post-test and recorded it, he had slowed down considerably. Trying to ascertain his reasoning, he remarked that it felt better and with a little more time he would improve. His own words can be verified in his endurance test. Thus showing that for this youngster, time and practice of a little longer length than the allotted time is needed.

Even if the class average showed no improvement and, in fact, a loss, one can really merit this test a place in the series because more than half the class improved, but owing to the fact that two losses of such considerable difference cut into the class average. Therefore, as this shows loss as well as gain and can serve as an index to potential swimming ability, experience will prove its worth in the series.

TABLE V

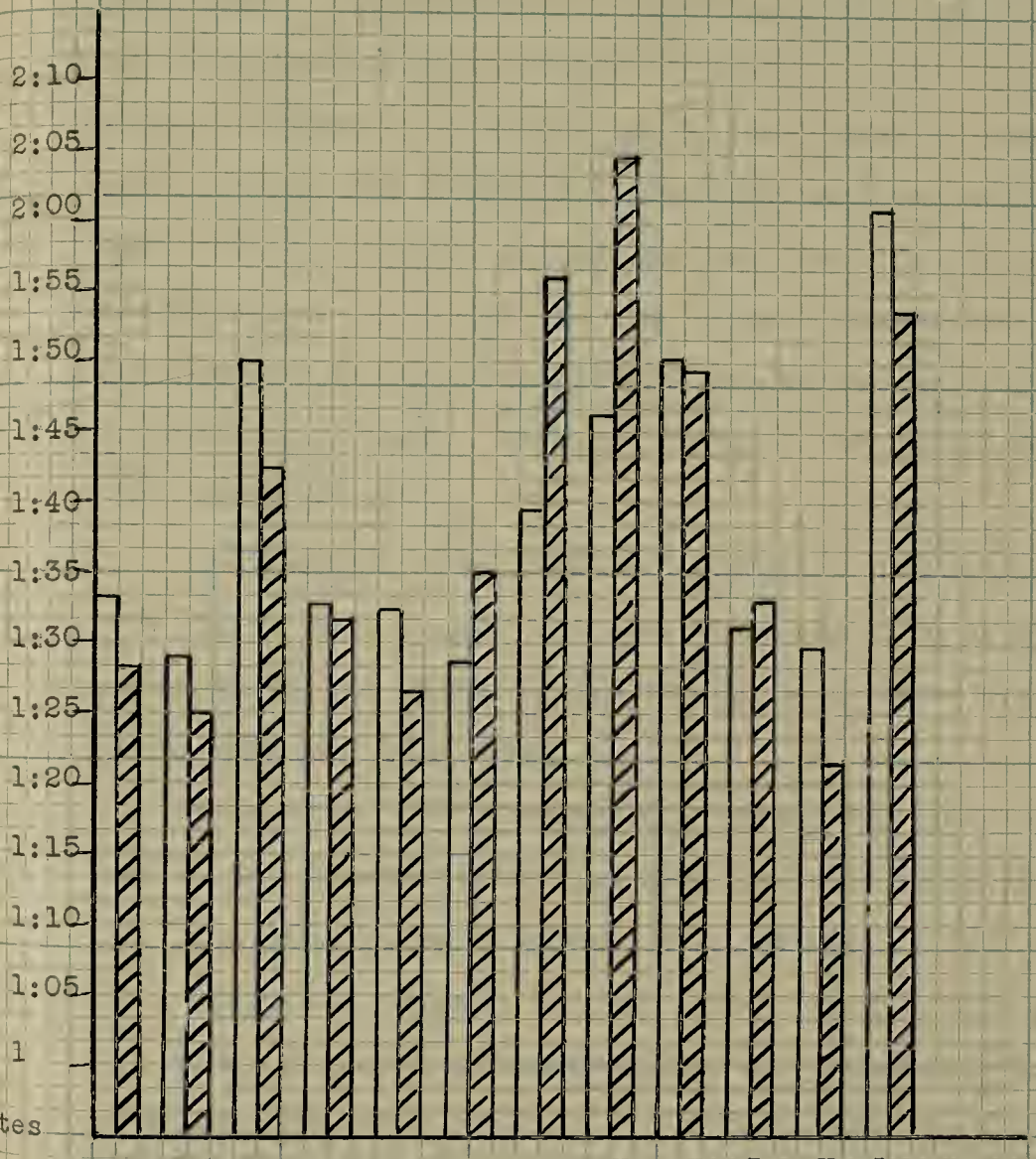
Table Showing Co-ordination Testing

Name	Pre-test Time	Post-test Time	Gain or Loss	
A	1:32.4	1:27	5.4 sec.	5.84%
B	1:28.2	1:24.4	3.8	4.30
C	1:47.4	1:41.1	6.3	6.36
D	1:31.5	1:30.1	1.4	1.53
E	1:31.2	1:25.3	5.9	5.46
F	1:37.8	1:53.3	- 5.8	-6.46
G	1:40	1:47.5	- 7.5	-7.50
H	1:37.8	1:33.3	-15.5	-16.84
I	1:44.3	3:02.3	-18.	-17.25
J	1:47.7	1:47.2	.5	.46
K	1:30.4	1:31.6	- .8	- .88
L	1:28.7	1:20.3	8.4	9.45
M	1:58.6	1:51.3	7.3	6.15
Average	1:37.4	1:38	.9	.7

Greatest Gain 9.45%

Greatest Loss 17.25%

Graph V Co-ordination Test of Experimental Group



ENDURANCE TEST OF EXPERIMENTAL GROUP

The culmination of all the tests is a gruelsome 400 yard swim. One has only to experience such a long swim to appreciate what the other fundamentals add in such a swim. However, the writer had a great deal of concern for at least the subjects attempting the long grind. At that only two failed on the pre-test to swim the maximum requirement. Also the one who dropped out at 250 yards was subject to physical ailment and so he was compelled to drop out. Later, however, he went the entire distance very satisfactorily.

Here again, after such a long swim, one cannot expect to find as high a gain and therefore the gain in seconds as shown on the Table VI can really be of more importance as to what has been done.

Even under such trying conditions, the greatest gain was 14.63% which speaks favorably for the individuals.

The loss is most interesting because it came from the best endurance swimmer in the class. He did very well on his first test and predictability as a long distance swimmer is highly probable because of his time and physical condition. He, of course, had a free style at the start and exerted a great deal of energy to swim the distance. When he finished his second test time and was slower by

17 seconds, he was content because he said he did not work as hard although he made very good time. This youngster even then stood above the class and therefore still proud of his achievement.

As before, the merits of this test are highly favorable for including it in the series. The 2.17%, shown as progress, is considerable for the type of test and worth more as a swimming test than others because it leads up to the culmination of swimming ability. Therefore this test is included and added to the series and in the experimental group, the interpretation is complete.

TABLE VI

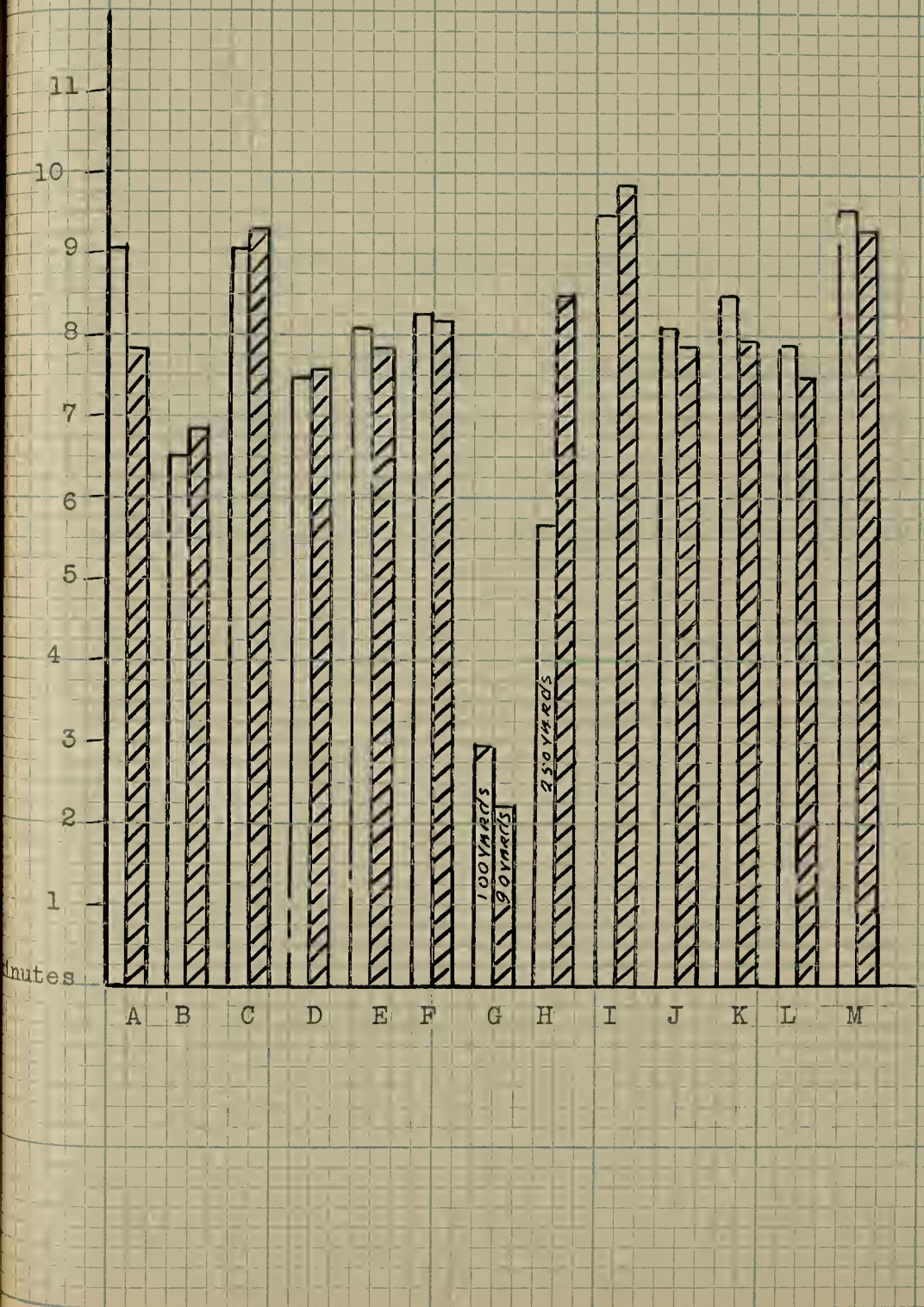
Table Showing Endurance Testing

Name	Pre-test Time	Post-test Time	Gain or Loss	
A	9:46.2	8:20.4	85.8 sec.	14.63%
B	7:06.4	7:23.5	-17.1	-3.10
C	9:43.8	9:58.3	-15.5	-2.65
D	8:05.2	8:12.1	-8. 9	-1.84
E	8:37.4	8:29.6	7.8	1.50
F	8:58	8:51.2	6.8	1.26
G	100 3:13.4	90 2:28		
H	250 1.44 6:02.5	400 1.33 9:06	150 yards .11	60 8.63
I	10:38	10:16.7	21.3	3.34
J	8:40	8:27.2	12.8	2.46
K	9:04.3	8:29.2	35.3	6.48
L	8:04.1	7:52.1	12	2.49
M	10:15.2	10:01.1	14.1	2.27
Average	8:59.7	8:48	11.7	2.17%

Largest Gain 14.63%

Largest Loss 3.10%

Graph VI Endurance Test of Experimental Group



TOTAL PERCENT OF EXPERIMENTAL GROUP

Table VII is a total percent scoring showing each individuals test progress or loss as a whole. Upon the average of the class in each of the six tests, the total average progress of the experimental group was 7.87%.

TABLE VII

Name	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
A	- 1.12%	- 2.38%	27.17%	12.53%	5.84%	14.63%
B	11.92	5.32	-28.23	22.84	3.39	- 3.10
C	4.92	40.79	5.44	7.23	6.06	- 2.65
D	3.27	-1.90	10.74	5.80	1.53	1.84
E	3.76	-1.93	6.45	- .29	-6.46	1.50
F	16.80	-6.49	21.46	- 6.05	6.62	1.26
G	9.97	-1.37		1.09	-16.84	
H	21.26	15.41	41.06	-5.60	5.50	8.63
I	17.26	3.33	44.47	-15.05	-17.25	3.34
J	21.05	-3.51	-10.18	- 5.29	.46	2.46
K	-12.29	1.18	40.68	.32	- .88	6.46
L	10.56	8.18	16.80	11.09	9.45	2.49
M	19.29	16.29	24.33	5.65	6.15	2.27
N	15.22					
Aver-age	10.83%	9.05%	21.34%	4.55%	-.70%	2.17%

Total Progress of entire group 7.87%

CHART II

Control Group Data

Name		Leg	Arm	Breathing	Speed	Co-ordination	Endurance
1	Pr'	19.8	20.5	38.7	40.5	1:08	5:54.6
	Po"	19.	17.6	33.4	39.6	1:03.2	5:43.7
2	Pr	22.5	22.5	26.7	37.4	59.7	5:18.1
	Po	22.3	22.7	26.3	36.9	58.1	4.37
3	Pr	17.5	22.2	36.7	44.4	1:02.3	5:35.4
	Po	18.1	18.9	39	42.1	58.4	5:18
4	Pr	24.3	21.4	29.7	44	1:09	5:39.5
	Po	25.1	29.6	27.5	43.6	1:07.2	5:19
5	Pr	20.4	25.4	26	51.4	1:12.4	6:36
	Po	19.7	25.2	25.4	51.1	1:08.3	6:32.4
6	Pr	20.5	24.2	33.4	45.5	1:05.8	6:10
	Po	20	23.4	25.6	44.7	1:01.1	5:51.2
7	Pr	21.5	25.6	29.7	55.7	1:17.6	6:59
	Po	20.8	23.2	28.6	52.3	1:16.4	6:48.2
8	Pr	15.1	23.1	27.7	47.3	1:09.2	6:06.3
	Po	14.2	22.7	26.8	45.6	1:08.7	6:04.2
9	Pr	23.4	24.6	30.9	54.4	1:18.1	7:09.8
	Po	22.8	23.8	20.7	50.2	1:07.3	6:15.4

Pr' = pre
Po" = post

CONTROL GROUP LEG TEST PROGRESS

The control group in this experiment was used primarily in the various tests to determine the validity of the particular test. These subjects used in this group are select and of the highest and most capable swimmers at the college. They have willingly offered their time because they too wanted to check their progress.

In the first test, 20.39 seconds was the group average before testing. After the ten week interval, the average of the same group was 20 seconds. This showed a progress of 1.90% which represents just about the amount a capable swimmer can improve with no formal instruction.

The largest single gain of 5.95% came from the leading subject in this leg action who has so manipulated his feet and to such a high degree of efficiency that there are many who cannot even swim one length of the pool using both the arms and legs.

There is a loss of 3.42% which is roughly six tenths seconds and hardly significant to warrant an explanation.

One important thing that can be readily seen is that the range of all the kicks did not vary more than 10 seconds from the poorest to the best. This is very good in showing one that the group has reached what can be called the peak of their skill in leg action.

TABLE VIII

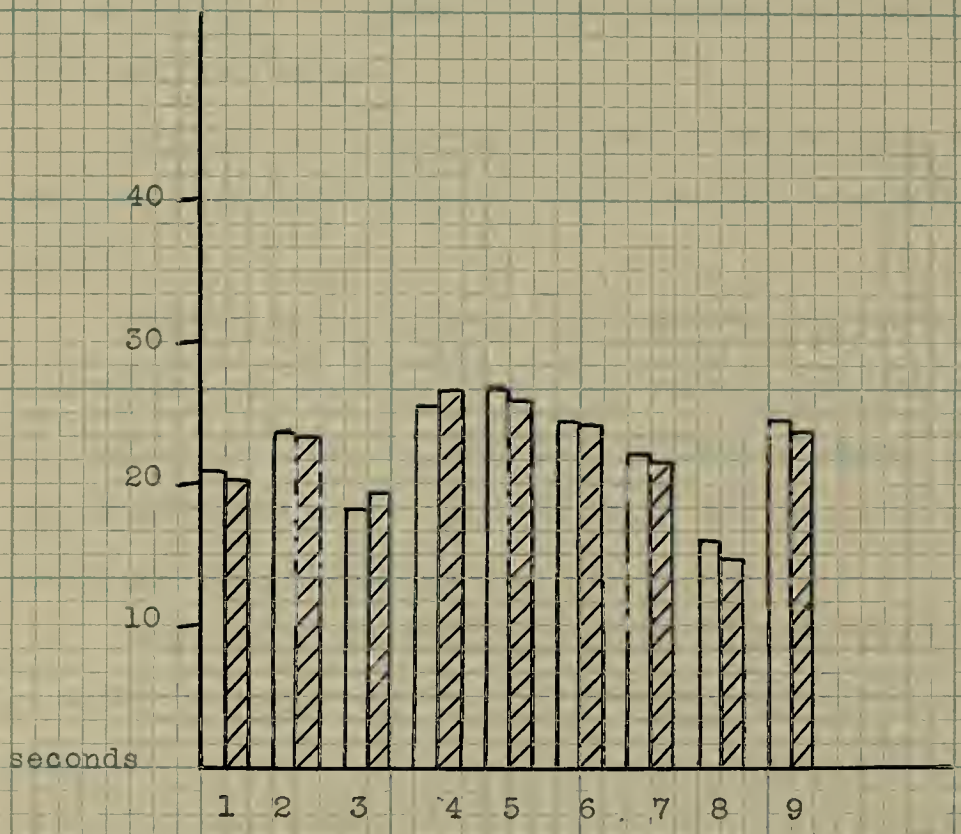
Showing Control Group Log Test Progress

Name	Pre-test Time	Post-test Time	Gain or Loss	
1	19.8	19	.8	4.04%
2	22.5	22.3	.2	.88%
3	17.5	18.1	- .6	- 3.42
4	25.8	- 25.1	- .3	- 1.20
5	20.4	19.7	.7	3.43
6	18.5	18.	.5	2.72
7	21.5	20.8	.7	3.33
8	15.1	14.2	.9	5.95
9	23.4	22.8	.6	2.60
Average Time	20.30	20		1.00%

Largest Gain 5.95%

Largest Loss -3.42%

Graph VII Control Group Showing Leg Test



CONTROL GROUP ARM TEST PROGRESS

Arms are very essential in good swimming and this group although not instructed has been highly conscious of the skill. In return, their progress has been better than one can expect.

As a group, the pre-test time averaged 23.2 seconds and the post-test time was 22.03 seconds or a gain of 5.39%.

One in this group had improved his arm action to the extent of 14.86%. This same subject also shows a gain in his later tests by just such an improvement. No. 3 as he is recorded on Table IX will also be worth a mention later due to this gain.

Here again can the short range between the best and poorest be seen. Again showing the group validity as a constant factor. It also offers the writer data for something the experimental group can attain when they reach this stage in age and experience.

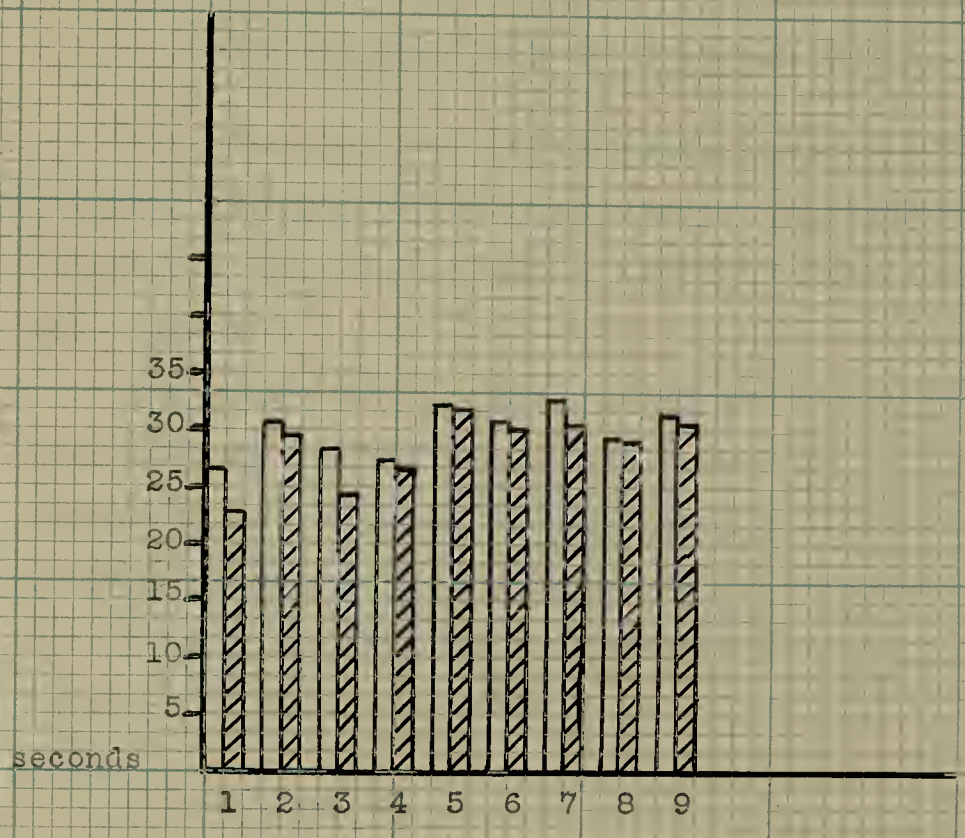
Showing Control Group Arm Test Progress

Name	Pre-test Time	Post-test Time	Gain or Loss	
1	20.5	17.6	2.9	14.14%
2	22.5	22.7	- .2	- .88
3	22.2	18.9	3.3	14.86
4	21.4	20.6	.8	3.73
5	25.4	25.2	.2	.78
6	24.2	23.4	.8	3.30
7	25.6	23.2	2.4	9.37
8	23.1	22 .7	.4	1.73
9	24.6	23.8	.8	3.25
Average Time	23.2	22.03	11.3	5.30%

Largest Gain 14.86%

Largest Loss - .88%

Graph VIII Control Group Showing Arm Test



CONTROL GROUP SHOWING BREATHING TEST

The breathing test even amongst these experienced swimmers showed progress which went to substaniate the contention that these students also were rather lax in the breathing.

The entire group showed a progress of 6.15% with 23.35% as the largest single gain and 6.23% as the largest loss. It is of no use to try to explain them as most of the subjects have never been observed only during tests and really gave this test little consideration after the first test.

TABLE X

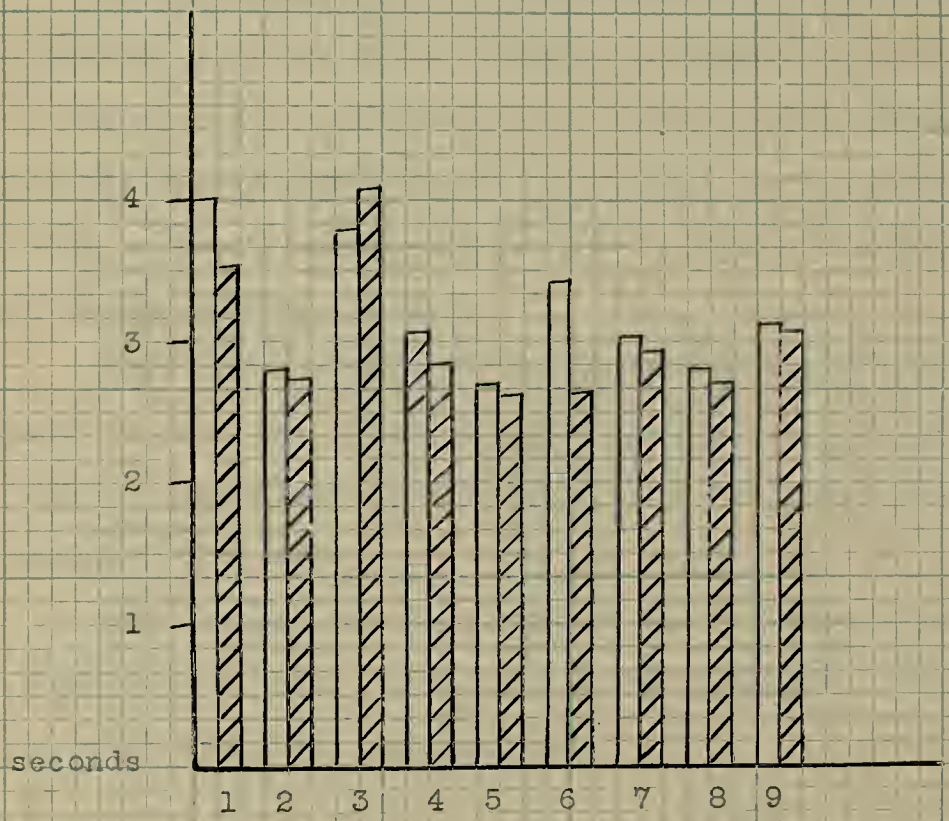
Showing Control Group Breathing Test Progress

Name	Pre-test Time	Post-test Time	Gain or Loss	
1	3.87	3.34	.53	13.69%
2	3.87	3.83	.04	1.49
3	3.87	3.90	- .23	-6.23
4	2.97	2.75	.22	7.40
5	2.60	2.54	.06	2.30
6	3.34	2.56	.78	23.35
7	2.97	2.85	.20	6.06
8	2.77	2.68	.09	3.24
9	3.09	2.97	.12	3.88
Average	3.10	2.91	1.72	6.18%

Largest Gain 23.35%

Largest Loss-6.23%

Graph IX Control Group Showing Breathing Test



CONTROL GROUP SHOWING SPEED TEST

In the speed test of the controlled group came the greatest range in time. Most of the group experienced the novelty of being tested for speed in this manner and all voiced a comment or two in regards to its practicality. These swimmers found it unusually awkward to swim and turn as designated by the test.

Just as an interest to the novelty was the writer able to make the group go through what they termed "silly test". Regardless of circumstances, the group had a progress of 2.98%.

The largest single progress was 7.90% and the smallest progress was .67%. This is the first test in which no recorded loss had been noticed.

TABLE XI

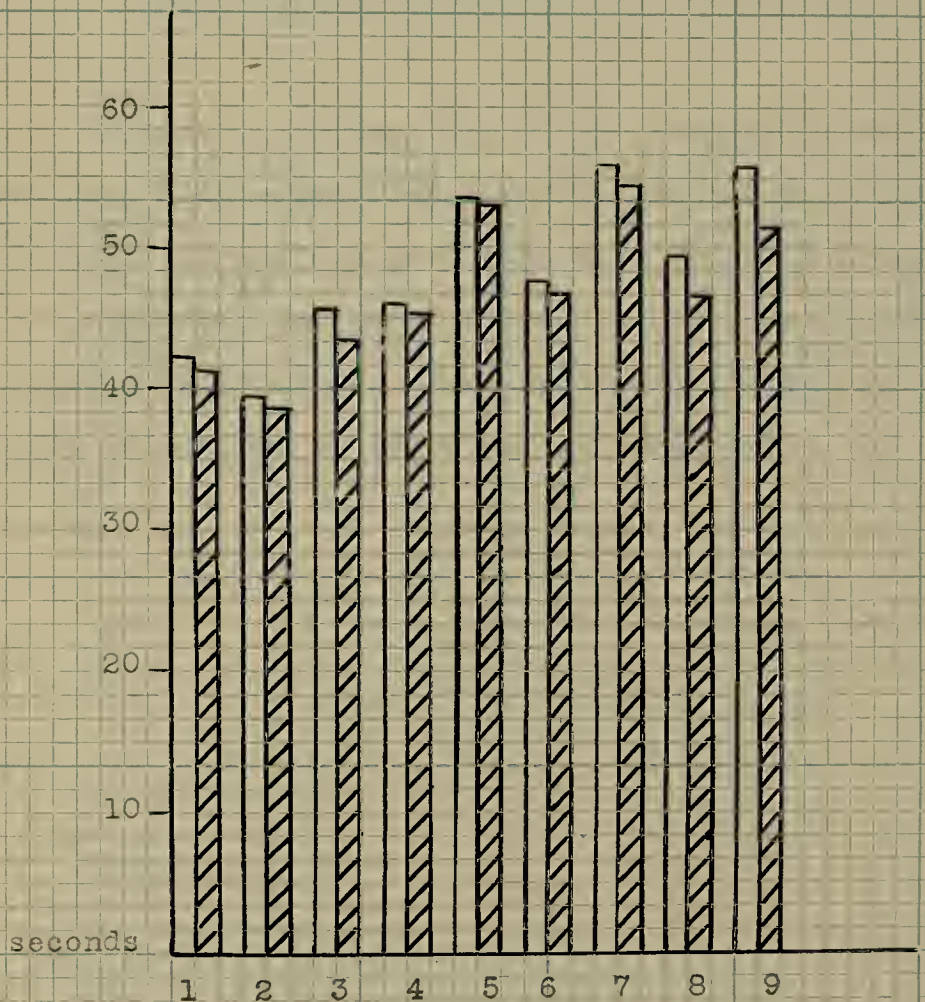
Showing Control Group Speed Test Progress

Name	Pre-test Time	Post-test Time	Gain or Loss	
1	40.5	39.6	.9	2.22%
2	37.4	36.9	.5	1.33
3	44.4	42.1	. 3	.67
4	44	43.6	.4	.99
5	51.4	51.1	.3	.58
6	45.5	44.7	.8	1.75
7	53.7	52.3	.6	1.11
8	47.3	45.6	1.7	3.59
9	54.4	50.2	4.2	7.90
Average	46.4	45.1	12.5	2.98%

Largest Gain 7.90%

Smallest Gain .67%

Graph X Control Group Showing Speed Test



CONTROL GROUP SHOWING CO-ORDINATION TEST

The co-ordination test of the controlled group produced an average of 68.1 seconds in pre-test time and 65.6 seconds for post-test time or 4.74% progress.

With only one great increase, No. 9 has produced a 13.83% in progress. Here again all the students at least maintained their former testing time.

TABLE XII

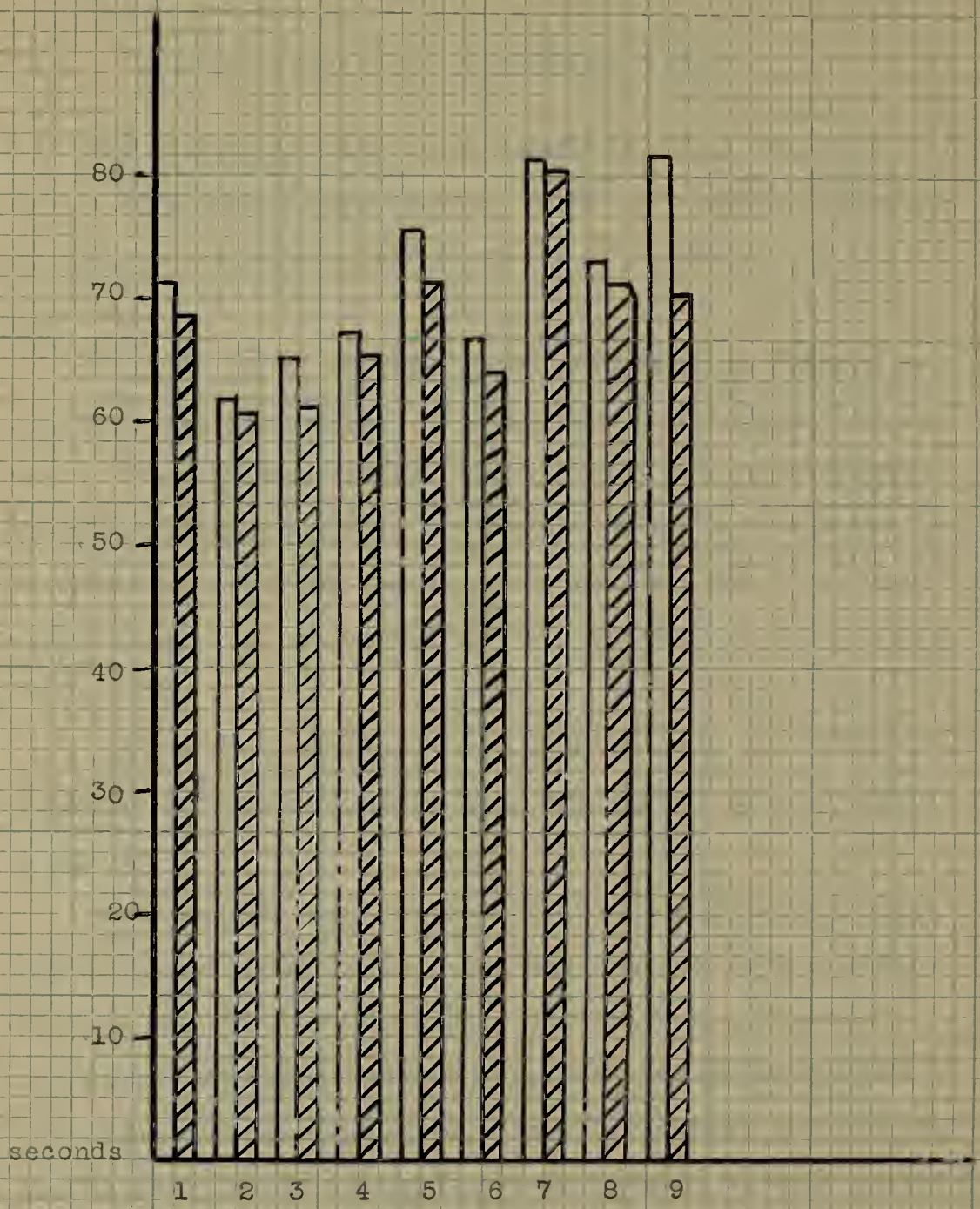
Showing Control Group Co-ordination Test Progress

Name	Pre-test Time	Post-test Time	Gain or Loss	
1	1:08	1:05.2	2.8 sec.	4.11%
2	62.7	60.1	1.6	2.68
3	1 :02.3	58.4	3.9	6.26
4	1:09	1:07.2	1.8	3.66
5	1:12.4	1:08.3	4.1	5.65
6	1:03.8	1:01.1	2.7	4.23
7	1:09.2	1:08.7	.5	1.54
8	1:17.6	1:16.7	1.2	.72
9	1:18.1	1:07.3	10 .8	15.83
Average	68.1	65.6	20.4	4.74%

Largest Gain 15.83%

Smallest Gain .72%

Graph XI Control Group Showing Co-ordination Test



CONTROL GROUP SHOWING ENDURANCE TEST

The endurance test in the control group has been one of very great importance. It is here w ere a knowledge of what caused this great increase of 7.88% can be explained.

This group of swimmers have been looking forward to the day when the college will sponsor a swimming team for them. They have practiced almost daily and consistently without tiring to attain that goal. They have all trained in hopes of at least keeping in condition for a few informal meets and consequently do something of this nature for a test.

Here they were almost too glad to have one take his time for 400 yards because they too wanted to know their progress.

Thus it was with renewed vigor and enthusiasm these fellows swam their tests. One has only to look at Table XIII to see just how fast they swim such a gruelsome distance. Therefore with a progress even greater than the experimental group, the writer has doubly assured himself that a series of tests can be made to measure progress in the ability of swimming.

TABLE XIII

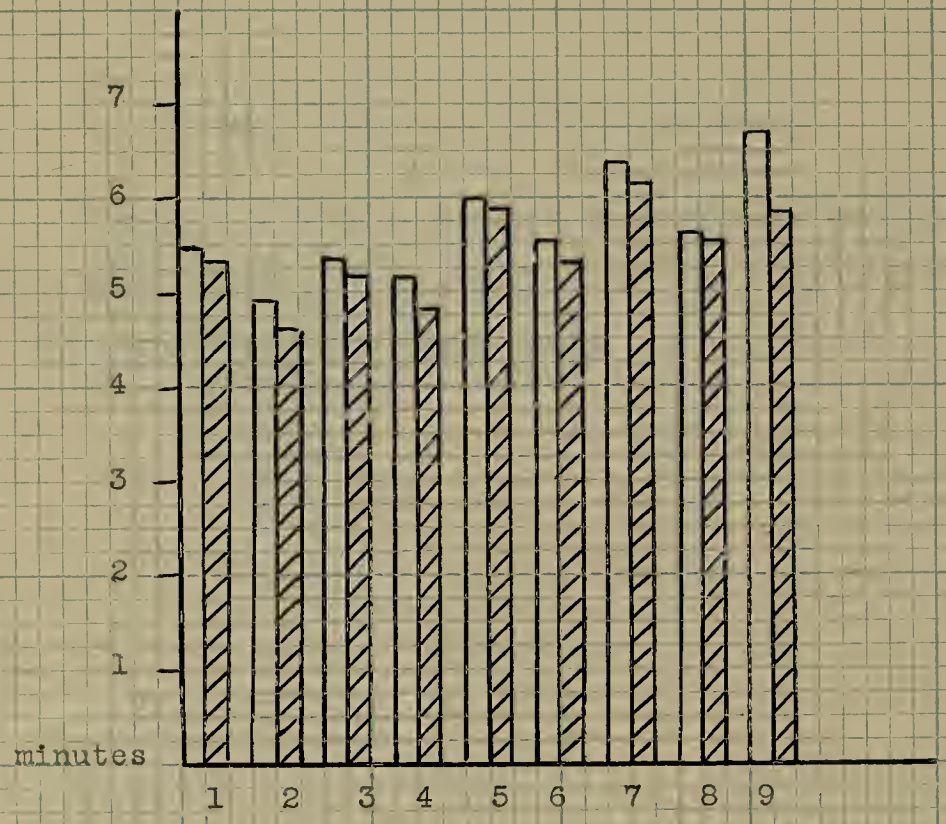
Showing Control Group Endurance Test Progress

Name	Pre-test Time	Post-test Time	Gain or Loss	
1	5:54.6	5:43.7	10.9 sec	3.07%
2	5:18.1	4:57	21.1	6.63
3	5:55.4	5:18	37.4	10.42
4	5:39.5	5:19	20.5	6.05
5	6:36	6:32.4	3.6	.99
6	6:10	5:57.2	12.8	3.45
7	6:50	6:48.2	1.8	.43
8	6:06	6:04.2	1.8	.49
9	7:09	6:15.4	53.6	12.49
Average	6:16	5:41.6	266.5 sec	7.88%

Largest Gain 12.49%

Smallest Gain .99%

Graph XII Control Group Showing Endurance Test



TOTAL AVERAGE OF CONTROLLED GROUP

Taking the entire groups' progress and totaling it by simple arithmetical means, 6.84% was found to be the progress of the controlled group.

Table XIV

Name	Leg Test	Arm Test	Breathing Test	Speed Test	Co-ordination Test	Endurance Test
1	4.04%	14.14%	13.69%	2.22%	4.11%	3.07%
2	.88	.88	1.49	1.33	2.68	6.63
3	3.42	-14.86	-6.23	.67	6.26	10.52
4	1.20	3.73	7.40	.99	5.65	6.03
5	3.43	.78	2.30	.58	5.66	.99
6	2.72	3.30	23.35	1.75	4.23	3.45
7	3.33	9.37	8.08	1.11	1.54	.43
8	5.95	1.73	3.24	3.59	.72	.49
9	2.60	3.25	3.88	7.90	13.83	12.49
Total	1.90%	5.39%	5.16%	2.98%	4.74%	7.88%

Total Average Class Gain in Percent 6.84%

SUMMARY & CONCLUSIONS

This experiment was attempted primarily to develop and use some tests in the specific activity of swimming. Six tests (1) Leg Test (2) Arm Test (3) Breathing Test (4) Speed Test (5) Co-ordination Test and (6) Endurance Test comprised the writer's tests.

The general progress of each group was as follows:

I Leg Test

a). Control Group..... 1.90%

b). Experimental Group..... 10.83%

II Arm Test

a). Control Group..... 5.39%

b). Experimental Group..... 9.05%

III Breathing Test

a). Control Group..... 6.15%

b). Experimental Group..... 21.34%

IV Speed Test

a). Control Group..... 2.98%

b). Experimental Group..... 4.53%

V Co-ordination Test

a). Control Group..... 4.74%

b). Experimental Group..... .79%

VI Endurance Test

a). Control Group..... 7.88%

b). Experimental Group..... 2.17%

CONCLUSIONS

The results of this experiment seem to indicate that progress in the fundamentals of swimming can be measured. From the six tests used in the experiment, the writer recommends the use of test numbers I, II, III, V, and VI as a battery of reliable tests for the measurement of swimming skill in fundamentals.

To objectively test an individual for potential swimming ability, the test must of necessity measure untaught skills. If this were not so, the individual could not be tested on his first appearance and the individual who had never swam would automatically be ruled out. This general ability test in this study seems to warrant the use of this test as a predictive test for potential swimming ability.

SUGGESTIONS FOR FUTURE EXPERIMENTATIONS

The writer recognises the limitations of this experiment where only 23 cases were used and therefore does not make any claim of finality, but it is hoped that this experiment may be suggestive to the many physical directors who are attempting scientific teaching in physical education. Without due deliberation, there are several places in physical education in which this type of effort might be made. The following are suggestive:

1). Instruction of individuals is enhanced

when the director knows the skill of each pupil. This is only possible when each student has been tested in the particular activity in which he is engaged.

2). Final grades can be more accurately given when actual scores are present.

3). Pupil interest, when seen by periodic testing of progress, can be highly developed.

4). Swimming team coaches can make wiser choices and better elimination of men from their squads (if compelled to) when their men remain on the squad on the basis of actual performance in tests than a mere opinion of one man.

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Walter J. Osinski

Approved by:

W. W. Welles

G. H. Lindsey

J. F. Anderson

Graduate Committee

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