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The purpose of this study was to investigate the difference, if any, in skill retention of students learning the elementary back stroke under two differing conditions. Both groups were taught by the demonstration, explanation, practice with correction method. The experimental group, in addition, was taught the mechanical principles governing the stroke.

Subjects were 35 men and women students enrolled in two beginning swimming classes at the University of North Carolina at Greensboro. Both classes were given elementary water skills before the study began. Then both were taught the elementary back stroke for this investigation, with the experimental group also instructed in the mechanical principles applicable to the stroke.

The Rosentswieg Revision of the Power Test was given after the $3\frac{1}{2}$ weeks of instruction on the stroke and again 6 weeks later, after a period of no practice on the elementary back stroke. An analysis of covariance and Fisher's "t" test for small uncorrelated groups were the statistical methods used to determine if there were a difference in retention scores.

Conclusions were drawn that the teaching of mechanical principles did not affect any changes different from those occurring with the group that received no instruction in the principles. Both groups retained the skill equally as well. There was no significant difference in the fluctuation within the group from the first and second test.

MECHANICAL PRINCIPLES AND RETENTION

OF THE ELEMENTARY

BACK STROKE

by

Pamela S. Peridier

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CHAPTER I

INTRODUCTION

Retention is an important aspect in the subsequent performances after motor skill learning. Skill learning is of little value unless it is retained for a substantial length of time. Being able to put to use what one has learned requires a high degree of retention. Improvement and further development of motor skills involves a building upon lower achievements. These achievements must be somewhat permanent in nature or time is wasted in relearning the simpler skills before the higher levels can be attained. Therefore, methods of improving retention should be of vital concern to the educator.

From a theoretical standpoint, it would seem that the understanding or discovery of the mechanical principles which are used in performance of the skill would aid retention. Knapp reasons:

> It also seems likely that when a skill has been learned, a knowledge of principles may aid in retention. Performance of complex skills which have been learned varies from day to day. An individual who knows the underlying principles of his skill can, when his skill is not as good as usual, refer to these principles in his mind and may possibly find the key to his fall-off in performance. The principles form a reference which is a useful aid to reformation of the skill. (4:29-30)

Research has not shown consistent results as to the immediate benefits of learning mechanical principles on motor skill performance. It appears that the learner can comprehend and understand the principles, but may not be able to apply them. Oxedine states that "the relationship between immediate proficiency and retention over a long period is not high." (7:99) The writer was interested in investigating whether the teaching of mechanical principles might affect retention, even though its effects on learning might not be immediately apparent. This study was therefore undertaken to discover the effects of a knowledge of the principles of mechanics on the retention of a specific skill, namely a swimming stroke.

CHAPTER II

STATEMENT OF THE PROBLEM

The purpose of this study was to investigate the difference, if any, in skill retention of students learning a swimming skill under two different methods of instruction. The study was conducted to determine whether the variable, the teaching of the mechanical principles governing the skill, had any effect on the retention of the skill.

CHAPTER III

REVIEW OF LITERATURE

Use of Mechanical Principles in Teaching Methodology

The following studies were undertaken to ascertain the value of mechanical principles, as a part of the teaching methodology, on performance and/or transfer.

Judd (25) used two groups of fifth and sixth grade boys, equated on brightness, in a study involving the throwing of darts at a target under water. One group was given a full theoretical explanation of refraction and the other was left to work out the experience without training. At first, the groups practiced throwing small darts at a target under 12 inches of water. He found that there was no difference in performance between the two groups; theory seemed to be no substitute for practice. Then the task was changed so that the target was under only 4 inches of water. The boys who had theory fitted themselves to the 4 inch depth very rapidly, while the others were confused. The practice gained at the 12 inch depth did not help the group without the knowledge of principles at the four inch deep target. The theory evidently aided the experimental group to see the adjustments in aim essential for a change of depth of target. Judd concluded that the teaching of principles of refraction did not help in the original learning situation, but did improve transfer from the original to another somewhat similar situation.

In 1941, Hendrickson and Schroeder (24) wanted to verify Judd's findings and also to vary his experiment slightly. They used eighth grade boys, divided into three groups: group one, which was the control group, group two (experimental group A), to whom the principles of refraction were explained, and group three (experimental group B), to whom the principles of refraction were explained plus the addition of a sentence drawing attention to the fact that changing the depth of the water changed the amount of refraction. The subjects used air guns as opposed to small darts used in Judd's study. The type of movement pattern was thus changed. The investigators concluded that a knowledge of theory facilitated both transfer and the original adjustment to the first situation. The definiteness or completeness of the theoretical information had a direct effect upon both the initial learning and transfer. Experimental group B learned faster than experimental group A. The typical boy in their study seemed to work unsuccessfully for a time, then quite abruptly reach a solution. The appearance of this moment of discovery, they concluded, was hastened in many cases by the theoretical explanation provided for in the experimental group. On the other hand, the large individual differences within each group and the consequent overlapping of the various groups in speed of learning suggests that success in the type of problem presented was probably conditioned by other factors in addition to knowledge of a theoretical principle as formulated by a teacher. Such additional factors may have included fluidity and variability of behavior when faced with a problem, a habit of verifying one's judgements, and the ability to formulate a general principle for oneself.

Renshaw and Postle (33) investigated the effect of knowledge of mechanical principles on performance on the pursuitmeter. On such an apparatus, the object is to keep the stylus on a small target, which is moving on a rotating disc. The time of the stylus contact is recorded by an attached clock. The experimenters used three groups of five subjects each. Group one, following a very brief demonstration, was merely instructed to keep the stylus in contact with the target for as long as possible. Beyond this, the subjects were left alone to learn as best they could. Group two, in addition to the above, was told to be as clever as possible and to use as much mechanical analysis as possible in finding the most effective method of performance. Group three, besides receiving the simple demonstration about the machine's operation, was read at each sitting a set of instructions which described in detail the known facts about the nature of the task, the best methods of operation, etc. Very little difference was reported to have appeared between the learning curves of the three groups after the first sitting. The curves for groups one and two showed only slight differences in general form and limits throughout the entire study. However, the curve for group three, after the second sitting to the end of the study, showed a marked difference in performance from groups one and two. Group three did not learn nearly as rapidly as did the other two groups. The authors postulated that the likeness of the curves for groups one and two was probably due to their similar methods in learning the task. They felt that group one probably employed analysis in an endeavor to find the most effective means for keeping the stylus in contact with the small disc, although not instructed to attempt analysis. They concluded that verbal instruction in an attempt to pass on knowledge of principles known to lead to success seems to impede and retard the acquisition of manipulatory skills.

Utilizing tennis, volleyball, and rhythms, Frey (39) studied the relative effectiveness of two teaching procedures. The experimental group was given a more elaborate analysis of the reason for the form and all questions were answered in great detail. The control group was given little analysis and questions were answered just briefly; however, the control group surpassed the experimental group in the majority of the tennis tests and in rhythms. The volleyball test results favored the experimental group. Frey concluded that the differences resulting from the teaching procedures were negligible as evidenced by the test results.

In 1949, Halverson (40) used four groups of subjects in a study of three methods of teaching the one-hand push shot. After a pre-test, one group did nothing but practice the shot mentally, a second group was given a demonstration followed by active practice, a third group was taught using a "kinesiological" method, and a fourth group acted as a control. In the "kinesiological" method, the learners were taught the mechanical principles involved in the skill so that they would be better able to direct their own performances of the skill. All three teaching emphases appeared to be effective in the development of the motor skills, however, mental practice was not as effective as the other two methods of teaching. The method stressing a knowledge of mechanical principles and the method emphasizing demonstration seemed equally effective.

Colville (16) conducted a study on the effect of knowledge of a principle of mechanics upon immediate learning of a skill to which the principle applied. She also dealt with the effects of knowledge of a mechanical principle learned in relation to one skill upon the subsequent learning of a different or more complicated skill to which the same principle was applicable. She selected three principles of mechanics which were pertinent to motor skills and three motor skills, each of which utilized one of the principles. With the learning time held constant, the experimental and control groups were compared for skill gain and transfer. The instruction concerning mechanical principles did not facilitate the initial learning or the transfer to any greater extent than an equivalent amount of time spent in practicing the skill. But, since it appeared that some part of the learning period devoted to instructions concerning general principles did not detract from the motor learning of the students, it would seem, deduced Colville, desirable to include such instruction in order to provide this additional opportunity for acquiring some related knowledge about principles of mechanics and the application of forces as they relate to motor learning.

Broer (14) was interested in whether the teaching of sports activities to junior high school girls could be made more effective if preceded by instruction in a general basic skills course which emphasized problem solving and understanding of simplified mechanics. Broer reported that with one-third as much time given to instruction in volleyball, two-thirds as much in basketball, and an equal amount in softball, the total experimental group surpassed the total control group on all eight sports skills tests. This difference was significant at the one percent level for three of the tests. The mean total sports skill score (on all eight tests) of the experimental group was also significantly higher than that of the control group. She said that these differences were not due to any initial superiority of the experimental group over the control group in general motor ability, physical development, or intelligence. Broer concluded that a general basic skills course using a problem solving approach to an understanding of simplified mechanics can lead to more efficient learning of specific physical education activities. She added that such a teaching approach was of interest to girls in the seventh grade. It is possible that some of the differences Broer found were due to greater interest and motivation.

Nessler (43) used 148 poorly skilled college freshman women in an experiment to compare the effects of participation in an eight-week basic skills course with participation in the required physical education program. She also studied the relative merits of the following two methods of teaching fundamental skills: 1) emphasizing the simple games and activities which stressed the skills of throwing, catching, running, etc. and 2) emphasizing isolated skill-practice, analysis, and discussion of the mechanical principles related to the specific skills listed above. In one part of her reported conclusions, Nessler stated the following:

> Skill learning for the poorly-skilled is not analytical. A knowledge of mechanical principles may be helpful in analyzing the completed act, but does not seem to aid the poorly-skilled in her performance. Poorly-skilled students are interested in the mechanical principles related to skill learning, but are unable to incorporate this theoretical knowledge into their performance of these motor skills. (43:148)

Cobane (15) compared the effectiveness of two methods of teaching tennis to beginners in achieving motor skill, knowledge, and understanding. One group of subjects was instructed by demonstration, explanation, practice and correction (traditional method). The experimental group received similar instructional methods with the addition of instruction in selected mechanical principles related to tennis. Cobane found no significant difference between the two groups at the end of the semester in the forehand, backhand, and serve. However, the experimental group was superior in knowledge and understanding as measured by a written examination at the end of the semester.

Mohr and Barrett (29) exposed students to simplified mechanical principles involved in the performance of the front crawl, back crawl, side and elementary back strokes and tested the hypothesis that this knowledge would enhance learning. They used 34 women enrolled in two intermediate swimming classes for fourteen weeks. The classes were found to be equated on form ratings on the elementary back stroke, front and back crawl, side stroke, a 25 yard sprint with the front and back crawl. Hewitt's glide test for the elementary back and side strokes, and reading comprehension (since much written material had been handed out). In the experimental group, Mohr and Barrett stressed application of the principles during the explanation and demonstration as well as in correcting individual performances. Both groups were given mimeographed analyses of the strokes, but the experimental group's papers also referred to the principles. Four written quizes were given. The results indicated that the experimental group did better in all but the elementary back stroke. Thus the findings support the hypothesis that exposing students to an understanding and application of mechanical principles produces greater improvement than instruction without reference to these principles.

In 1968, Fath (38) conducted a study to determine whether a traditional teaching approach consisting of demonstration, explanation, and teacher directed practice as contrasted to a traditional teaching approach with the addition of an understanding of the mechanical principles governing the stunts differed with regard to learning. Subjects included 39 college freshman and sophomore women enrolled in two beginning gymnastics classes. The study lasted for four weeks. Ratings for each subject on each of the twelve beginning tumbling stunts were determined by three raters both at the beginning and the end of the study. In addition, three new tumbling stunts were tested at the time of the retest. Fath found that both groups improved in skill. Neither teaching approach seemed to be more effective in the improvement of tumbling skills from the beginning to the end of the study and neither teaching approach proved more effective in the final tumbling skill of all subjects. The two groups learned the new stunts equally well.

In summary, it seems that the effectiveness of knowledge of mechanical principles on improvement of performance has not been upheld consistently in research. Perhaps the learners are not skilled enough to put what they know into practice, or perhaps they can learn best in a trial and error, non-analytical method. (6:110)

The effect of knowledge of principles on transfer depends a great deal on the nature of the two skills and on the nature of the explanation. It seems that knowledge of mechanical principles has little effect on transfer in complex sports skills. No research was found that dealt with the effect of knowledge of mechanical principles on retention of motor skills.

Verbalized Instruction

One rarely finds an organized learning situation in which there are no verbal directions. Concerning instruction in physical activities, verbalization may be used for directions as to procedures, motivation, improvement of feedback of results, and for imparting knowledge. When relating mechanical principles to motor skills, one most often verbalizes. Therefore, the effect of verbal instruction, as a method of imparting knowledge of mechanical principles, is a factor to consider in this study. The value of teacher use of verbal methods varies with the nature and purpose of the verbal instructions, the nature of the student, and the nature of the task.

The following studies deal with the nature and purpose of teacher verbalization and its effects on performance.

Davies (18) carried out an investigation on the effect of tuition upon the process of learning the complex motor skill of archery. Her experimental and control groups of twenty girls each were very similar in height, weight, mental ability, previous physical education experience, and motivation. One class was given regular and systematic instruction in the technique of archery. The other class practiced under the observation of the experimenter, but without any instruction except for that necessary for safety. Although the curves for both classes had decreasing gains and were similar in pattern, the class receiving the verbal instruction learned faster than did the non-tuition class during the initial and later stages of learning. The tuition group was given instruction before they even shot the arrows, and started at a higher level of performance. Tuition had no effect on individual day to day, or even within any practice period, variations. Competition seemed to improve the scores for the tuition group, but was not as effective for the uninstructed group whose imperfectly organized skill tended to break down under stress. The non-tuition group acquired a fairly successful technique - successful in terms of the immediate scores - and was then unwilling to change, whereas the tuition group was willing to attempt change when suggested by the instructor even though there was a temporary loss in score. In summary, Davies found that verbal instruction in archery as to how to perform improved performance.

Berlin (37) studied the effect of five different teaching methods on the rate of acquisition of a specific skill in each of the following sports: golf, soccer, fencing, tennis, and lacrosse. The subjects were all given a general orientation to the five skills, then were taught the five skills one at a time with different instruction methods for each skill. The methods used after the orientation were: 1) demonstration plus practice, 2) trial and error practice, 3) verbal instruction plus practice, 4) visual aids plus practice, and 5) a combination of the preceding four. Each method was tried out on each skill but with a different group. Each group experienced all methods, i.e., golf was taught to group A by demonstration and practice, to group B by trial and error, etc. The trial and error method seemed to be the most efficient method, with the combination ranking second. After preliminary orientation, the group without further verbal guidance did better than the group with additional verbal guidance.

Twenty $4\frac{1}{2}$-year old children were trained for fifty days in throwing rings over a post in Goodenough and Brian's (23) study. The twenty subjects were divided into three groups: group A included ten children who were given no instruction or criticism with regard to their methods of throwing; group B of six children who were given a brief preliminary demonstration and subsequent verbal criticisms, but were not required to adhere to a constant procedure in grasping and throwing the rings; the four children who made up group C were instructed the same as group B except that they followed a certain definite procedure in throwing and were not allowed to experiment with any other method. The amount of improvement averaged the least for A, next for B, and there was much improvement with group C.

Using fifty college students, Rivenes (44) tried to determine the effects of demonstration with and without verbal explanation on motor skill acquisition and retention. He used students who were novices in golf putting and soccer instep kicking. Demonstrations were presented to the non-verbal group during the second and sixth practice session during the learning period for each skill. Demonstrations and two to three minutes of explanation were presented to the verbal group during the same practice dates. The subjects practiced until they reached a predetermined criterion and then did not practice again for the next eight weeks. At the end of the interim, the subjects started to relearn the skills up to the previous criterion. For both groups, Rivenes measured learning rate, retention, knowledge of form and performance of the skills by means of a written test, and the rate of relearning. The only significant differences between the groups were in the scores on the written test with the verbal group ranking higher. Intercorrelations indicated that the knowledge test score was related to the number of rounds required to relearn for the verbal group only. This seemed to indicate that while there were no significant differences between the verbal and non-verbal groups in terms of rate of learning and relearning, the verbal group may have learned differently by employing the verbal knowledge in some way.

Nelson (30) used ninety men taking college physical education and taught them six paired motor skills with the order and method as variables. Observations seemed to warrant the following general conclusion in relation to verbal instruction: the method of deliberate teaching for transfer of learning through verbalization at the beginning levels of learning appeared to be ineffective in the subsequent learning of skills with similar patterns and movements.

Cratty expresses the opinion that the most effective placement of verbal instruction seems to be during the pre-performance phase and the initial stages of task performance. (3:51) Increasing the specificity of instructions seems to produce improved performance increments in some cases and to deter performance in others. If the skill can be taught and understood without much explanation, teacher verbalization seems to have no value in performance except as a means of motivation or perhaps to facilitate transfer. (5:63) Explanation may either hinder or improve retention. If the students can already see their results, verbalization to aid in feedback of results may be extraneous and even distracting if carried out while practice is continuing. Verbal instructions do not seem to be of much help in facilitating transfer of learning from one situation to another similar situation. As to verbalization for motivational purposes, the main problem is whether or not the teacher's words are really having motivating effects. (5:63)

The value of verbal instruction also depends upon the nature of the student. Accurate descriptions tend to become technical and drawn out. This creates uncertainty, boredom, frustration and impedes learning. Young children and beginners have difficulty in comprehension. Ragsdale comments about the novice learner:

> In the beginning do not rely too much on words... He will not understand the directions. He may be able to give you the meaning of every word used; he may be able to repeat the directions; but he has not connected the words with the movements of his hands and body. Directions are just empty words until the pupil has already learned something about the new task, until he has already developed a fair degree of skill. He must first build up a movement vocabulary before he can understand and profit by directions given in words. (8:325)

Words may help the older, skilled student to a greater degree, especially in directing him to focus on a part which needs correction or emphasis. The words now have meaning in terms of past experiences. Regardless of age or skill level, some students seem to profit from verbal guidance more than others.

The nature of the task is a very important consideration in determining the value of verbalized instruction. Some skills, such as the pursuit motor skill, are very difficult to describe verbally.

Battig (13) conducted a study concerning verbal training and skill complexity. He found verbal pretraining to facilitate performance on simple motor tasks, but to be of no benefit on complex tasks. The subjects were tested on a finger positioning apparatus.

Knapp suggests that when the motor side of a skill is relatively unimportant and the learning involves the noting of changes in the environment and reacting to them correctly, then verbal pretraining can be valuable. This would apply to such skills as those required in sailing. When the motor aspect is very complex, then preliminary verbal training is apparently of little use. (4:26) Knapp also says that when the technique or motor aspect is very important to the end result, then instruction plays a large part in improvement. These skills include such activities as Olympic gymnastics, diving, throwing and jumping events, and swimming. When one comes to activities in which change in motor adjustments to adapt to varying changes in environment is extremely important (the so-called open skills), self instruction and discovery become more valuable. (4:30)

Although verbal instruction may be of some benefit, it seems to be much less valuable than actual motor skill practice. Descriptions and ideas are one thing, experience another.

Retention

Retention is the persistence of knowledge or skills which have been learned. Forgetting is the failure to retain that which has been learned. Retention and forgetting are essentially opposites of the same phenomenon. One hundred percent retention equals zero percent forgetting; twenty percent retention equals eighty percent forgetting. (7:99)

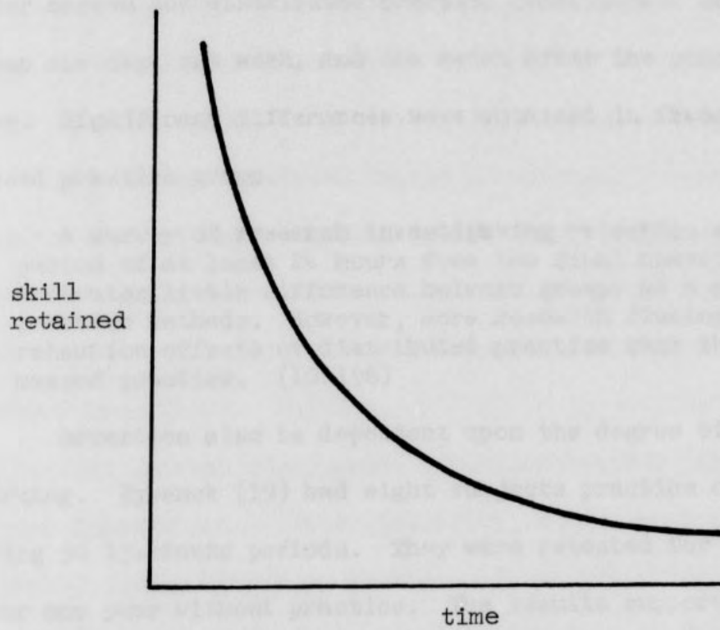
Generally retention curves follow a pattern which is illustrated in Figure 1.

The descent of the curve is affected by such factors as: 1) the kind of practice schedule by which the material was learned, 2) the degree of original learning, 3) interpolated experiences, 4) the meaningfulness of the material, 5) verbal vs. non-verbal material, 6) fine vs. basic skill, 7) the technique of measurement, and 8) the time lapse between the learning and the recall situation.

Retention depends on the practice schedule by which the material was learned. Fleishman and Parker (20) reported, on a highly complex tracking test, that the retention was unrelated to the distribution of the practice in the original learning. Reynolds and Bilodeau (34), using an apparatus involving the rudder control test, a complex coordination test, and a rotary-pursuit test, found that the effects of distributing practice were noticeably more advantageous throughout the experiment and on the first and second retention tests, but both groups demonstrated similarly in performance on the retention test given ten weeks later. Lewis and Lowe (27), using the SAM Complex Coordinator,

Figure 1

Retention Curve



had one group of subjects practice steadily for twenty minutes in each of the fifteen sessions. The distributed group practiced and then was allowed thirty seconds of rest after each trial. A four month later retention test suggested that the conditions of practice seemed to have no differential effects on retention. Massey, and Cook and Hilgard (28) (17) in their respective studies found similar results. Singer (35) investigated the retention of a novel basketball skill practiced under massed and distributed practice conditions. Retention tests were given one day, one week, and one month after the conclusion of practice. Significant differences were obtained in favor of the originally massed practice group.

> A survey of research investigating retention effects after a period of at least 24 hours from the final moment of practice indicates little difference between groups as a result of the practice methods. However, more research findings favor the retention effects of distributed practice over the effects of massed practice. (10:196)

Retention also is dependent upon the degree of the original learning. Eysenck (19) had eight subjects practice on the pursuit rotor during 50 15-minute periods. They were retested for 3 15-minute periods after one year without practice. The results support the prediction that retention of a perceptual-motor skill that has been well developed is remarkably good, even after one year.

Ammons and his co-workers (11) reported a study of long term retention of a perceptual-motor skill. The skill was a sequential manipulation of a series of control on a compensatory pursuit task. Some of his subjects were trained to a moderate and some to a high degree of skill. He reported that a greater proportion of proficiency was lost by groups receiving less training. Fleishman and Parker (20) reported, on a highly complex tracking test, that the most important factor in retention was the level of proficiency achieved during initial learning. Purdy and Lockhart (31) reported a study of retention of five novel motor skills by 36 college women after 9 to 15 months of no practice. They concluded that the fast learners are better retainers than the slow learners. Although fast learners may forget more than slow learners, they have learned so much more that they are still superior to the slow learners in total amount retained, i.e., they are still superior in the skill after the extended no-practice interval.

Therefore, all other things being equal, research has shown that the amount of initial learning is directly related to the amount retained. Retention has been demonstrated to be higher when the task is well learned. Partially learned material is forgotten faster than mastered material.

Interpolated experiences affect retention. The amount of interference depends on: 1) its similarity, 2) the amount of practice of the original, 3) the amount of practice of the interference, 4) general activity, and 5) future use of the information to the individual. The things we typically learn are not isolated, but rather fall into sequential patterns of various learning materials. Because of this fact, the learning and retention of a response might very well be affected by what is learned, especially if it is of a related nature, before and after training in the desired activity. Proactive inhibition refers to the negative effect one learned task has on the retention of a newer task. Retroactive inhibition refers to the condition when a recently learned task impairs the retention performance of an older learned task. Motor skills are not forgotten quickly, mainly because they are practiced longer and more frequently, hence learned better.

The technique of measuring recall, or retention, influences retention results. In the recall method, the individual must draw from memory without cues. The general technique of recall can be used quite successfully for determining retention in physical activities as scores are not just recorded as correct or incorrect; instead, there are varying degrees of correctness. However, the individual might completely forget correct moves, yet recognize them when seen, so there is still some retention. The best method for measurement is the relearning method. The individual might not have any remembrance, but when he starts practicing he will get the feeling quite rapidly. At least, he will find that the skill is learned again in less time. This economy or savings is usually evidence that there is some retention. The relearning technique is the most sensitive detector of retention for both verbal and motor skills. (7:104-5)

The amount of verbal and non-verbal learning often seems to affect retention. It is uncommon to find any organized learning situation where verbal directions are not given by the instructor before and during practice. The things one usually learns are often mediated by words. The ability to succeed in motor performance may be related to a certain extent in being able to apply external and internal words to motor activities. Sometimes, however, the verbal mediation process may interfere with skilled performance. The performer thinks too much and gets confused, resulting in a delayed reaction to a given situation.

Rivenes (44) experimented with the learning of golf putting and of soccer kicking by complete novices. The control group was given demonstrations for the first 4-5 minutes of the first 6 practices, but no verbal guidance. His experimental group had exactly the same demonstrations, plus 2-3 minutes of carefully planned verbal explanations and descriptions. Rivenes measured learning rate and retention (after 8 weeks). The only significant difference between the two groups in either the learning or retention was in the scores on a verbal written test in which the subjects tried to furnish verbal answers describing form and performance of the skills. Verbal instructions had no effect on retention.

Fine or more detailed points of a motor skill are forgotten more quickly than basic features. This may be due to the relative importance the motor skill achievement has to the individual, the total body effort intellectually and physically needed to perform the basic skill, and the number of hours devoted to the basic skill learning as compared to the fine aspects.

An important consideration as to what is retained is the meaningfulness to the learner of that which is learned. The manner in which the material is structured, its relationship to the learner's previous experience, and the aspects which the learner views as necessary, affect retention. It also seems that the understanding or discovery of a principle which is basic to the material may sometimes aid retention. Materials that are learned by drill are not as well remembered. Certain motor skills, especially to children, are held in high worth and therefore are very meaningful to them. There is a relative permanence to the meaningful material which we learn.

The last thing that affects retention is the time lapse between the learning situation and recall. Yet the time lapse is perhaps insignificant compared to the other aspects that influence retention. Nonsense syllables are almost completely forgotten; the major aspects of bicycle riding are remembered almost forever. Swift (36), using himself as a subject, learned to type over a 50 day period. Two years later it took him only 11 days to reach the same proficiency he had before.

Reminiscence

Reminiscence occurs when the curve of forgetting is reversed. Reminiscence is the phenomenon resulting in improvement instead of decrement in the recall of a task after a period of rest.

Fox and Young (21) instructed two groups of students for 6 weeks and 9 weeks in badminton skills. They were tested after 6 weeks and 12 weeks of no practice on a wall volley test and short serve test. No reminiscence was noted on the short serve test. Reminiscence did occur in the wall volley after the six week non-practice interval for the group having 9 weeks of instruction, and after the twelve week non-practice interval for the group having 6 weeks of practice.

Purdy and Lockhart (31) tested subjects one year after they had learned five novel skills, e.g., ball toss and foot volley. They discovered that 89% of the subjects displayed reminiscence in one or more of the skills.

Fox and Lamb (22) investigated reminiscence in learning softball skills by 7th grade girls. On the basis of their data, it was concluded that improvement in softball skills of batting for distance and repeated throws did occur during a long interval without practice. In the absence of other factors which could explain the improvement, it appeared to them that reminiscence is more apt to occur after a relatively long non-practice interval than after a short period of time.

From the limited amount of research in this area, it appears that an optimal period for reminiscence varies with the task, from a few minutes with nonsense syllables to a few months or more with athletic skills. Reminiscence may be due to mental practice and it is believed to occur, when it does, only when the task has been partially learned. However, loss of skill level is more common after extensive periods of no practice than is reminiscence.

CHAPTER IV

PROCEDURES

This study was conducted to investigate the effects of two different teaching methods on retention of the elementary back stroke in swimming. Method one consisted of a traditional approach (explanation, demonstration, practice). Method two consisted of a traditional teaching approach with the addition of explanations of the mechanical principles which govern the performance of the skill. The procedures below were followed to ascertain if a statistically significant difference resulted in groups, instructed by the differing methods, in retention of the elementary back stroke.

Selection of Subjects

The subjects used for this study were 35 men and women college students enrolled in two beginning swimming classes at the University of North Carolina at Greensboro. The class designated as the experimental group met on Mondays and Wednesdays from 2:15 to 2:50 P.M. and included 19 women and 2 men. The control class met on Tuesdays and Thursdays from 2:15 to 2:50 P.M. and included 14 women.

Method of Instruction

Both classes were given the same instructions for the first $2\frac{1}{2}$ weeks of class on the basics of getting adjusted to the water, floating, flutter kicking, recovery from prone and supine floating, release of cramps, etc. Then the first stroke to be learned, the elementary back stroke, was taught to the two groups, but with different aspects of method within the respective groups. The steps in teaching involved demonstration, explanation, then practice with correction. The difference in method was a difference in nature of explanation furnished the experimental group from that furnished the control group. The explanation phase for the control group consisted of descriptions of the skill and cues for performance. The explanation phase for the experimental group included a description of the skill and cues for performance plus the teaching of basic mechanical principles and their theoretical application to the elementary back stroke. A detailed description of the principles may be found in Appendix A. The correction phase for the control group brought the error to the attention of the performer and gave him or her an idea of the desired change. The phase for the experimental group, in addition to correcting the error, consisted of relating the error and correction to the mechanical principles involved. The lesson plans appear in greater detail in Appendix B. After the instructional period for the stroke, both classes continued on to the front crawl and other swimming skills. Both classes were then taught similarly without any references to mechanical principles or to the elementary back stroke. The classes were taught by the writer to avoid variance in personality, and an attempt was made to teach both with equal enthusiasm.

Experimental Conditions

Both groups met approximately the same length of time for each class meeting, however the additional explanation of mechanical principles reduced the amount of physical practice time for the experimental group by two to three minutes per class period. All subjects were beginning swimmers who had never learned, or who had learned very little about the elementary back stroke. Both classes were taught the stroke for the same length of time, $3\frac{1}{2}$ weeks, and then were given the first test. During the instructional period for the elementary back stroke, subjects who were absent or who only observed classes made up the work during recreational swim. Thus, all participants had the same amount of class time devoted to the stroke. The subjects were told not to practice the stroke outside of class during the interim between the first and second test. The second test was given six weeks later.

Selection and Administration of the Tests

The Rosentswieg Revision of the Power Swimming Test (32) was used in this study. The test for the elementary back stroke begins with the subject in the water, lying on his back, with his legs held up to the water surface by an assistant. The shoulders are parallel to the starting line and then the feet are released and the subject swims six complete strokes. Two trials are allowed with the score in distance of the best trial recorded. Since the correlation between form and power has been demonstrated to be low, subjective ratings of form were disregarded. Subjective judgment was thus decreased. It was also felt that the delayed stroking, sculling, and/or additional kicking, which was to be controlled by the rating, could be regulated by the writer by observing each swimmer's performance and by requesting those performing improperly to repeat the test. This test was selected over others because it is fairly valid and does provide an objective measure of the power and efficiency of the stroke. Subjects, before the post-test, were allowed to practice for two minutes on the stroke.

Treatment of Data

In treating the data for this study, the best of the two measures for each subject was recorded for the pre-test and the post-test in both groups. An analysis of covariance was applied to determine if there were a significant difference between the experimental and control groups on the retention of the stroke. Fisher's "t" test was also used to determine if there were a significant difference between the groups in the amount of change from the pre-test to the post-test.

CHAPTER V

ANALYSIS OF DATA

The purpose of this study was to investigate the effect of the teaching of mechanical principles on retention of the elementary back stroke. Pre-test and post-test scores for 35 subjects were used for statistical analysis to determine if there were a difference between the control and experimental groups. Raw scores for all subjects are presented in Appendix C.

Null hypotheses were formulated, and a significance of difference at the five percent level of confidence was considered an acceptable standard at which to reject the hypotheses. The hypotheses tested were in terms of:

a. differences in retention between the two groups,

b. differences between the two groups in the amount of change from the pre-test to the post-test scores.

Differences in Retention Between the Two Groups

The writer was interested in knowing if there were a statistical difference between the experimental and control groups on the retention of the elementary back stroke. The null hypothesis formulated was: there is no significant difference between the retention scores of the experimental and control groups.

The groups for this study were not equated since the writer used two scheduled physical education classes in the required program at the University of North Carolina at Greensboro. Although both were beginning classes, it was felt that possible variations in skill between the two classes justified the use of analysis of covariance for testing the hypothesis, as it provides for an adjustment in groups as related to initial and final scores.

No significant difference in retention was found between the groups. The F ratio from the analysis of covariance, reported in Table 1, indicates nonsignificance at the five percent level of confidence. The null hypothesis is therefore accepted; both groups retained the skill equally as well.

Differences Between the Two Groups in the Amount of Change From the Pre-Test to the Post-Test Scores

The writer was also interested in determining if there were a significant difference in the variability between the pre-test and post-test scores of the experimental and control groups. This null hypothesis was stated as follows: there is no significant difference between the two groups in the amount of change from the pre-test to the post-test scores.

Fisher's "t" test for small uncorrelated groups was used for statistical analysis. The data appearing in Table 2 shows that a "t" of .844 was obtained, which is not significant at the five percent level of confidence. Thus, the null hypothesis was found tenable; the teaching methods did not affect the variability between the pre-test and post-test scores.

Table 1

Analysis of Covariance Between the Retention
From the Pre-Test to Post-Test Between
the Experimental and Control Groups

SOURCE OF VARIATION	SUM OF SQUARES	df	MEAN SQUARE	F
Between groups	8.872	1	8.872	.572
Within groups	496.696	32	15.522	

Table 2

Significance of Difference Between the Control and Experimental Groups on Changes From Pre-Test to Post-Test Scores

GROUP	N	$\bar{D}$	"t"
Experimental	21	0.381	.844
Control	14	1.500	

Interpretation of Data

The analysis of covariance showed that there was no difference in retention of the elementary back stroke between the group taught by the traditional method and the group taught mechanical principles along with the traditional method. Apparently the use of two to three minutes of each practice period to explain the mechanical principles applicable to the skill did not cause any greater retention in the experimental group than that shown by the control group, which had no explanation of principles.

Through observation of the raw scores, it can be seen that in some cases forgetting occurred; performance was lower on the post-test. In two cases, there was no change between the pre-test and post-test scores. In other cases, reminiscence appeared; there was an improvement in scores after a six-week period of no practice. Although the stroke was not practiced or mentioned during the six-week interim between the first and second tests, the improvement in scores may be attributable to mental practice of the stroke and to the students, over the period of time, becoming more accustomed to moving in the medium of water, due to practice on other strokes during the interim. Through the application of the "t" test, it was found that the changes from the pre-test to post-test scores were not significantly different in the control and experimental groups. Moreover, the teaching of mechanical principles did not seem to change the fluctuation within the groups to any greater extent than did the traditional method alone.

These results support the conclusions reached with the majority of studies done on the effect of teaching mechanical principles on learning. (15) (16) (38) (39) (40) (43) Apparently the subjects cannot apply the mechanical principles to immediate learning or to later reconstruction of the skill.

In summary, the data obtained in this study indicates that there was no difference in retention of the elementary back stroke after six weeks of no practice between the group taught by the traditional method and the group taught the traditional method with the addition of the mechanical principles applicable to the stroke.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was conducted to investigate the difference, if any, in skill retention of students learning the elementary back stroke under two differing conditions. Both groups were taught by the demonstration, explanation, practice with correction method. The experimental group, in addition, was taught the mechanical principles governing the stroke.

Subjects were 35 men and women students enrolled in two beginning swimming classes at the University of North Carolina at Greensboro. Both classes were given elementary water skills before the study began. Then both were taught the mechanical principles applicable to the skill.

The Rosentswieg Revision of the Power Test was given after the $3\frac{1}{2}$ weeks of instruction on the stroke and again 6 weeks later, after a period of no practice on the elementary back stroke. An analysis of covariance and Fisher's "t" test for small uncorrelated groups were the statistical methods used to determine if there were a difference in retention scores. The following results were obtained:

1. There was no significant difference in retention between the two groups.

2. There was no significant difference between the two groups in the amount of change from the pre-test to the post-test scores.

The findings of the study resulted in the following conclusions:

1. Both groups retained the skill equally as well. Apparently the use of two to three minutes of each practice period to explain the mechanical principles did not cause any greater retention in the experimental group than that shown by the control group, which had no explanation of the principles.

2. Forgetting, no change, and reminiscence occurred from the pre-test to the post-test within each group.

3. The fluctuation within the groups was not affected by the teaching methods.

Recommendations

1. Groups should be taught for a full semester with the mechanical principles being applied to the entire course work.

2. The interim between the two tests should be occupied with an activity different from that being taught for the study.

3. Advanced skill students should be used to determine if the teaching of mechanical principles might affect different changes in retention from those found in this study.

4. Other activities besides swimming should be investigated.

BIBLIOGRAPHY

A. BOOKS

1. Broer, Marion. Efficiency of Human Movement. Philadelphia: W.B. Saunders Company, 1966.

2. Bunn, John. Scientific Principles of Coaching. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1955.

3. Cratty, Bryant. Movement Behavior and Motor Learning. Philadelphia: Lea and Febiger, 1967.

4. Knapp, B. Skill in Sport. London: Routedge and Kegan Paul, 1963.

5. Lawther, John D. The Learning of Physical Skills. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1968.

6. Lawther, John D. Psychology of Coaching. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1951.

7. Oxedine, Joseph B. Psychology of Motor Learning. New York: Appleton-Century-Crofts, 1968.

8. Ragsdale, Clarence E. Modern Psychologies and Education. New York: Macmillan Company, 1932.

9. Scott, M. Gladys. Analysis of Human Motion. New York: F.S. Crofts and Company, 1942.

10. Singer, Robert N. Motor Learning and Human Performance: An Application to Physical Education Skills. New York: Macmillan Company, 1968.

B. PERIODICALS

11. Ammons, R.B., R.G. Fen, E. Block, E. Neumann, M. Day, R. Marion, and C.A. Ammons. "Long Term Retention of Perceptual-Motor Skills," Journal of Experimental Psychology, LV (April, 1958), 318-328.

12. Battig, William F. "The Effect of Kinesthetic, Verbal, and Visual Cues on the Acquisition of a Lever-Positioning Skill," Journal of Experimental Psychology, XLVII (May, 1954), 371-380.

13. Battig, William F. "Transfer from Verbal Pre-Training to Motor Performance as a Function of Motor Task Complexity," Journal of Experimental Psychology, LI (June, 1956), 371-378.

14. Broer, Marion R. "Effectiveness of a General Basic Skills Curriculum for Junior High School Girls," Research Quarterly, XXIX (December, 1958), 379-388.

15. Cobane, Edith. "A Comparison of Two Methods of Teaching Selected Motor Skills," Dissertation Abstracts, XX (February, 1960), 3182.

16. Colville, Frances M. "The Learning of Motor Skills as Influenced by Knowledge of Mechanical Principles," Journal of Educational Psychology, XLVIII (October, 1957), 321-327.

17. Cook, Barbara and Ernest R. Hilgard. "Distributed Practice in Motor Learning: Progressively Increasing and Decreasing Rests," Journal of Experimental Psychology, XXXIX (April, 1949), 169-172.

18. Davies, D.R. "The Effect of Tuition Upon the Process of Learning A Complex Motor Skill," Journal of Educational Psychology, XXVI (September, 1945), 352-365.

19. Eysenck, S.B.G. "Retention of a Well Developed Motor Skill After One Year," Journal of General Psychology, LXIII (October, 1960), 267-273.

20. Fleishman, Edwin A. and James F. Parker. "Factors in the Retention of Perceptual-Motor Skill," Journal of Experimental Psychology, LXIV (September, 1962), 215-226.

21. Fox, Margaret and Vera P. Young. "Effect of Reminiscence on Learning of Selected Badminton Skills," Research Quarterly, XXXIII (October, 1962), 386-394.

22. Fox, Margaret G. and Ethel Lamb. "Improvement During a Nonpractice Period in a Selected Physical Education Activity," Research Quarterly, XXXIII (October, 1962), 381-385.

23. Goodenough, Florence L. and Clara R. Brian. "Certain Factors Underlying the Acquisition of Motor Skill by Pre-School Children," Journal of Experimental Psychology, XII (April, 1929), 127-155.

24. Hendrickson, Gordon and William H. Schroeder. "Transfer of Training in Learning to Hit a Submerged Target," Journal of Educational Psychology, XXXII (March, 1941), 205-213.

25. Judd, C.H. "The Relationship of Special Training to General Intelligence," Educational Review, XXXVI (June-December, 1908), 28-42.

26. Leavitt, Harold J. and H. Schlosberg. "The Retention of Verbal and of Motor Skills," Journal of Experimental Psychology, XXXIV (October, 1944), 404-417.

27. Lewis, Don and William F. Lowe. "Retention of Skill on the SAM Complex Coordinator," Proceedings of the Iowa Academy of Science, LXIII (1956), 591-599.

28. Massey, Dorothy. "The Significance of Interpolated Time Intervals on Motor Learning," Research Quarterly, XXX (May, 1959), 189-201.

29. Mohr, Dorothy R. and Mildred E. Barrett. "Effect of Knowledge of Mechanical Principles in Learning to Perform Intermediate Swimming Skills," Research Quarterly, XXXIII (December, 1962), 574-580.

30. Nelson, Joseph B. "Studies of Transfer of Learning in Gross Motor Skills," Research Quarterly, XXVIII (December, 1957), 364-373.

31. Purdy, Bonnie J. and Aileene Lockhart. "Retention and Relearning of Gross Motor Skills After Long Periods of No Practice," Research Quarterly, XXXIII (May, 1962), 265-272.

32. Rosentswieg, Joel. "A Revision of the Power Swimming Test," Research Quarterly, XXXIX (October, 1968), 818-819.

33. Renshaw, Samuel and Dorothy K. Postle. "Pursuit Learning Under Three Types of Instruction," Journal of General Psychology, I (1928), 360-367.

34. Reynolds, Bradley and Ina McD. Bilodeau. "Acquisition and Retention of Three Psychomotor Tests as a Function of Distribution of Practice During Acquisition," Journal of Experimental Psychology, XLIV (July, 1952), 19-26.

35. Singer, Robert N. "Massed and Distributed Practice Effects on the Acquisition and Retention of a Novel Basketball Skill," Research Quarterly, XXXVI (March, 1965), 68-77.

36. Swift, Edgar J. "Memory of Skillful Movements," Psychological Bulletin, III (1906), 185-187.

C. UNPUBLISHED MATERIALS

37. Berlin, Pearl. "Effects of a Varied Teaching Emphasis During Early Learning on Acquisition of Selected Motor Skills." Unpublished Doctoral dissertation, The Pennsylvania State University, 1959.

38. Fath, Judith Ann. "A Study of the Effect of Two Different Methods of Teaching on Gymnastics." Unpublished Master's thesis, The University of North Carolina at Greensboro, 1968.

39. Frey, Bernice G. "A Study of Teaching Procedures in Selected Physical Education Activities for College Women of Low Motor Ability." Unpublished Doctoral dissertation, State University of Iowa, Iowa City, 1947.

40. Halverson, Lolas Elizabeth. "A Comparison of Three Methods of Teaching Motor Skills." Unpublished Master's thesis, The University of Wisconsin, 1949.

41. Hertz, Gilman W. "The Effectiveness of Three Methods of Instruction in One-Hand Foul Shooting." Unpublished Doctoral dissertation, Indiana University, Bloomington, 1956.

42. Kearns, Nancy Jean. "A Study of an Analytical and Kinesiological Approach to Teaching Bowling." Unpublished Master's thesis, Women's College of the University of North Carolina, 1960.

43. Nessler, Joan. "An Experimental Study of Methods Adapted to Teaching Low-Skilled Freshman Women in Physical Education." Unpublished Doctoral dissertation, The Pennsylvania State University, 1962.

44. Rivenes, Richard S. "Effects on Motor Skill Acquisition and Retention of Teaching by Demonstration With and Without Verbal Explanation." Unpublished Master's thesis, The Pennsylvania State University, 1961.

APPENDIXES

APPENDIX A

ANALYSIS OF THE ELEMENTARY BACK STROKE

Basic Mechanical Principles

1. Buoyancy - If an object placed in the water displaces an amount of water equal in weight to the weight of the object, the object will float partially out of water until that part which is left under water displaces an amount of water weighing as much as the total object. If the water displaced weighs less than the object, the object will sink. Most people float, but at varying levels. The density of each person's body varies with bone structure, weight, body fat, muscle, etc. The more dense the body, that is, the heavier the bones, the greater the proportion of muscle over fat, the more water one needs to displace in order to float. If part of the body is raised out of the water when swimming, the amount of water displaced is correspondingly reduced. The body reacts as a whole and it, therefore, tends to sink because of the decreased buoyant force of the water.

2. Action-Reaction - For every action, there is an opposite and equal reaction. This effect can be readily seen when a swimmer pushes backward against the water; the water moves backward as the swimmer moves forward. The effect cannot be seen when a runner pushes backward against the earth, due to the earth's tremendous weight in relation to that of the runner's. In swimming, if one pushes down, the body will

rise upward. A push upward sends the body down. When the recovery phase of a stroke is performed under water, pressure is exerted in a direction which tends to send the body the wrong way. Therefore, in swimming one must find ways to reduce this oppositional force.

3. Force and Factors Affecting Force - All progression is dependent upon the application of force against a resistant surface. In swimming, the water offers less resistance than most other mediums or surfaces, and thus progress through the water is slow and requires effort. Efficient use of force is imperative in swimming. Maximum force is attained by presenting as large a surface area as possible to the desired direction, by pushing the surface through as great a distance as possible in the direction opposite the desired path, and by moving the surface as fast as possible. During the recovery phase, all these aspects should be minimized, i.e., presentation of as small a surface area as possible, movement of it through the least possible distance, and performance of the movements slowly.

4. Inertia and Momentum - An object which is at rest or in motion will remain in the same state at the same speed, or lack of speed, and in a straight line unless acted upon by a force. This tendency of a body or object to remain in its present state of motion is known as inertia. Since it takes more force to start an object moving than to keep it going, the timing of the strokes in swimming, especially those with a gliding phase, is extremely important to the efficiency of the stroke.

Whip Kick

From the glide position, the legs are recovered against the direction of movement. This motion tends to retard the forward progress and therefore must be executed slowly. The knees are bent in recovery to reduce the surface area presented and to shorten the lever for an easier recovery. The body is held straight to reduce excessive resistance to motion.

The ankles are flexed so that the toes can lead out before the drive, reducing the resistive surface and positioning the feet such that they can extend and add to the kick. The leg movement is limited in range so that it is impossible to get a push directly back against the water. The legs are always pushing on the water at an angle to the line of progress, the angle varying with the width of the kick. The wider the kick, the greater the backward push component and thus the more forceful the kick.

The first backward pressure against the water is applied by the front and inside of the legs, but the soles of the feet are almost immediately brought into play. Flexing the ankles gives a greater surface area with which to push. The final force of the kick results from the squeezing of the water backward as the legs come together.

On the glide, the legs are held straight and together with pointed toes to streamline the body and reduce resistance.

Arm Action

During the recovery phase, the arms are moved slowly and are kept as close to the body as possible to reduce resistance and opposing force. The arms are kept under water to permit the body to float as high as possible during the stroke. If the arms are recovered too close to the water surface, they will produce a splash and slow down the motion. As the arms start to extend outward in preparation for the drive phase, the fingers lead out to minimize resistance. The arms then extend diagonally out above the shoulders at approximately a 45° angle. Reaching high overhead increases the distance over which the force can be applied, but in accordance with the action-reaction principle, the straight direction of movement of the swimmer is not affected, but a great amount of energy is wasted. On the drive phase, the palms face the direction of pull to increase the surface area pushing on the water. For the same reason, the arms are extended, besides their lengthening the lever and thus increasing the distance over which the push is effective. As the arms approach the side of the body, they become less effective in producing force, although there is some value to this part of the pull. At the end of the drive phase, the arms are held close to the body in order to streamline the body.

Coordination of the Complete Stroke

As an object moves through the water there is a tendency for the water to be pushed ahead of it. This effect is exaggerated as the surface presented to the water becomes larger and flatter. In a horizontal position, the top of the head and shoulders and parts of the arms and legs push against the water. A swimmer whose legs hang low in the water finds that progress is hindered by the drag produced by the legs. The position of the head influences the position of the whole body. If it is too high out of the water, the feet tend to sink and thus resistance is increased. Any adjustment to streamline the body or to avoid holding the arms or legs out in an extended position will facilitate movement.

APPENDIX B

LESSON PLANS *

LESSON I

Control

1. Introduction to stroke
   a) resting stroke, done on back, requires moderate effort, uninterrupted breathing
   b) demonstration of stroke

2. Kick
   a) demonstration - explanation
      1) heels drop to bottom of pool
      2) bend from knees only
      3) feet turn out
      4) circle feet wide to side
      5) knees stay close together
      6) press around and together
      7) glide with legs straight and together
   b) land drill
   c) bracket drill
   d) with flutter board

Experimental

1. Introduction to stroke
   a) same
   b) mechanical principles explained that will be referred to later
      1) action-reaction
      2) inertia and momentum
      3) force and factors affecting its application
      4) buoyancy
   c) demonstration of stroke

2. Kick
   a) - d) same as in control

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* Only those lessons involving the elementary back stroke.

	Control	Experimental
LESSON II	1. Warm ups 2. Review kick a) brief explanation b) bracket drill c) with flutter board d) free floating	1. Warm ups 2. Review kick a) - d) same 3. Application of principles to kick
LESSON III	1. Review kick - laps 2. Arm action a) demonstration - explanation 1) recover with bent elbow, hands staying close to body 2) creep hands up, lead out with fingers to arm pull at 45° angle 3) press all the way down 4) hands touch sides of legs on glide b) land drill c) stationary drill with partner d) moving drill with flutter kick 3. Complete stroke a) demonstration b) practice	1. Review kick a) review principles b) laps 2. Arm action a) - d) same e) application of principles to arm motions 3. Complete stroke a) - b) same

Lesson	Control	Experimental
LESSON IV	1. Review complete stroke a) demonstration - explanation 1) arms start recovery first 2) legs then recover 3) arms and legs press together 4) glide 5) mention of body position b) practice	1. Review complete stroke a) same with addition of principles of mechanics governing the actions b) same
LESSON V	1. Practice stroke 2. Swimming in deep water	1. Practice stroke 2. Swimming in deep water
LESSON VI	1. Practice stroke 2. Practice on modified power test	1. Practice stroke 2. Review all mechanical principles and their applications to the stroke 3. Practice on modified power test
LESSON VII	1. Power test	1. Power test

APPENDIX C

RAW SCORES

SUBJECT	EXPERIMENTAL		CONTROL	
	Pre-	Post-	Pre-	Post-
1	26	24	29	27
2	22	29	18	19
3	28	25	29	29
4	22	19	39	44
5	29	33	12	16
6	19	18	21	20
7	28	23	26	33
8	43	44	23	25
9	19	21	13	15
10	29	28	27	35
11	16	20	28	25
12	41	38	36	41
13	18	17	23	18
14	49	50	23	18
15	41	37		
16	18	23		
17	16	20		
18	20	17		
19	29	26		
20	27	27		
21	31	40		