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Improving skill analysis for diving

Rush, Deborah A., Ph.D.
The Ohio State University, 1990

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IMPROVING SKILL ANALYSIS FOR DIVING

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy in the
Graduate School of The Ohio State University

By

Deborah A. Rush, B.S., M.S.

The Ohio State University

1990

Dissertation Committee:
Dr. Daryl Siedentop
Co-Advisor
Dr. Deborah Tannehill
Co-Advisor
Dr. Sandra Stroot

Approved by:

School of Health, Physical Education, and Recreation
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The purpose of this study was to investigate the effectiveness of graphic and video training protocols on analytic and diagnostic skills used for diving. The study also examined the extent to which analytic and diagnostic skills generalized to trained and untrained dives. The design used for the study was a multiple probe baseline design across four basic dives; forward dive, back dive, inward dive, and forward dive half twist. Subjects included fourteen volunteers who had an interest in swimming, diving, and/or physical education.

The study was conducted over a five week period. Graphics and video interventions were administered in a sequential fashion for all four dives. Performance assessment tests were administered after each intervention. Performance assessment tests asked subjects to verbally and
visually identify critical performance elements, discriminate major errors, and diagnose which error to correct first for each of the dives observed. Generalization testing was administered following completion of all training protocols.

Data was visually analyzed. Results indicate that baseline measures for analysis and diagnosis capability of subjects were low. Induction did occur for both analysis and diagnosis due to similar verbal labels used to describe critical performance elements and major errors. Subjects with diving and coaching experience were able to use information they learned from interventions better than subjects with no diving training. Proficiency levels for both analysis and diagnosis improved significantly after graphics interventions. Subjects were able to maintain and/or continue to improve analytic and diagnostic proficiency levels after video interventions. Training for diagnosis was not as effective as training for analysis with the method employed. Analytic and diagnostic skills acquired through training protocols were generalized to trained and untrained dives.
To my Mom, Dad, family, and Nathan for all your
courage, support, and love.
ACKNOWLEDGEMENTS

To Dr. Daryl Siedentop, thank you for your guidance, support, and encouragement on this study.

To Dr. Deborah Tannehill, your friendship, advice, and support have been immeasurable. Thanks for always making time for me in your busy schedule.

To Dr. Sandra Stroot, your enthusiastic assistance and editing contributions were greatly appreciated.

To LG, we've come along way! Thanks for all your encouragement, and for making me laugh when I needed it the most.

To my fourteen subjects, thank you for your commitment and enthusiasm throughout the study.

To Vince Panzano, thanks for teaching me to keep chipping at that big rock.

To Nathan, for helping me out on numerous tasks throughout this dissertation, and for always being there.

To my Mom, for inspiring me to become a physical educator and continuing school.
VITA

September 5, 1959 .............. Born, Utica, New York

1982 .......................... B.S., Physical Education
The Ohio State University
Columbus, Ohio

1984 - 1985 ..................... M.S., Teacher Education,
Ithaca College, New York

1985 - 1987 ..................... Instructor, Diving Coach
Skidmore College,
New York

1987 - 1989 ..................... Assistant Diving Coach
Graduate Assistant, The
Ohio State University,
Columbus, Ohio

1989 - 1990 ..................... Graduate Teaching
Assistant in Physical
Education, The Ohio State
University, Columbus,
Ohio

FIELDS OF STUDY

Major Field: Physical Education
Field of Study: Sport Pedagogy
Dr. Daryl Siedentop
Dr. Deborah Tannehill

Minor Field: Psychology
Field of study: Counseling
Dr. Rich Russell
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CHAPTER I
Introduction

Much of the teacher effectiveness research has mentioned teacher feedback as an important variable for student learning (Berliner, 1979; Rosenshine, 1979). Appropriate feedback messages given by the teacher or coach after a student response can help to enhance performance (DeKnop, 1986; Masser, 1987). This process of providing effective feedback to the learner has also been referred to as 'clinical diagnosis' (Hoffman, 1982). Hoffman refers to clinical diagnosis as "decisions made by the skill instructors regarding the nature of the learners performance problems and the factors that gave rise to them". Clinical diagnosis requires making three decisions. First, was the skill performed correctly? If not the teacher must decide which feature of the skill was performed incorrectly. And lastly, the instructor is confronted with deciding which error should receive prescription.

Training teachers and coaches to observe sport performances, identify discrepancies between correct
and incorrect performances, and provide appropriate feedback to the learner is an important agenda for teacher and coach education.

When a teacher or coach lacks the ability to analyze and detect errors in student performance, feedback statements result in a general comment, an incorrect diagnosis, or no comment at all, none of which facilitate improvement in student performance. A teachers/coaches skill at analyzing and diagnosing sport performance is a pedagogical skill of critical importance.

A common trend has been to assume that preservice teachers and coaches acquire skills of analysis and diagnosis through a combination of knowledge gained in required undergraduate courses; specifically kinesiology, biomechanics, and sport skills courses. Research however has shown that the skill analysis ability of physical education teachers gained from undergraduate programs is minimal (Biscan & Hoffman, 1976; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983). It appears that professional courses required of preservice physical education teachers are not providing adequate information for teachers and coaches to bridge the gap between kinesiology and sport skill analysis. The relationship between pedagogy and
kinesiology has worn thin and the fundamental considerations of how, why, and under what conditions the physical education teacher observes movement has been ignored (Hoffman, 1977). Effective skill analysis and diagnostic training methods are needed within the preparation programs of physical education instructors.

Teachers need to be trained to observe and analyze sport movement without the aid of special instruments, in a clinical or "real" setting. Hoffman (1977) has suggested a move toward pedagogical kinesiology as an effort to bridge the gap between kinesiology and pedagogy.

'Pedagogical Kinesiology' focuses on the clinical diagnosis and improvement of skilled performances in applied settings. Specifically, the teacher's interaction with the student about the sport skill performance becomes the central focus. Some unique characteristics of pedagogical kinesiology include (Hoffman, 1977):


2. Teachers trained to discriminate correct and incorrect response characteristics for a given sport
skill through observation training programs.

3. Sport skills evaluated on a qualitative basis with specific parameters for each response.

4. Skill analysis training is accomplished in simulated or field based settings where real performance efforts, not contrived, are studied.

5. Terminology of pedagogical kinesiology is based on brief summary labels and sharp picture words that are specific to the skills being analyzed.

Instrumentation for training and evaluation of a student's ability to analyze sport skills is an important key in the development of pedagogical kinesiology.

During the past decade a number of studies have focused on sport skill analysis. While some of these studies have examined the analytical abilities of physical education instructors (Armstrong & Hoffman, 1979; Biscan & Hoffman, 1976; Hoffman & Armstrong, 1975; Osborne & Good, 1972), others have begun to investigate effective training methods for teaching sports skill analysis (Gangstead & Beveridge, 1984; Halverson, 1987; Kniffen, 1985; Morton, 1989; Wilkinson, 1986; Ulrich, 1977).
While steps are being taken toward the improvement of skill analysis proficiency in physical education teachers, the field of coaching has been virtually unexplored. Sport skill analysis proficiency would appear to be an essential skill for coaches to acquire. Research in this area has shown that coaches do demonstrate more proficiency at analyzing specific sports than physical education teachers (Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983). Differences in proficiency levels, however is only minimal (Armstrong & Hoffman, 1979; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983). With coaches only providing appropriate feedback 50% of the time (Imwold & Hoffman, 1983), skill analysis research needs to focus on developing effective instructional skill analysis training programs to increase coaches proficiency in sport skill analysis.

Statement of the Problem

The sport of diving relies heavily upon effective coaches who can teach and coach execution of technically correct dives. Developing proper mechanics in a beginning diver is essential for continued progress. Due to lack of extrinsic feedback available in diving, divers must rely on their coaches ability to
observe, analyze, and diagnose performance. The tutorial style used by diving coaches involves working with each individual on a one-to-one basis, and providing feedback to divers after each attempt of a dive. Developing clinical diagnostic skills are essential for effective coaching of diving.

The purpose of this study is to investigate the effectiveness of graphic and video training protocols on the analytic and diagnostic skills for diving. Subjects will learn to analyze and diagnose performance of four beginning dives. A graphic protocol will focus on analytic skills and a video protocol will focus on diagnostic skills. Analytic and diagnostic performance will be assessed prior to and after each intervention in a sequential fashion. After training is completed, a final test will also examine the extent to which analytic and diagnostic skills generalize to untrained dives.

Research Questions:
1. How accurately do subjects identify and visually discriminate the critical performance elements of selected dives prior to intervention?
2. How does graphic intervention affect subjects capability to accurately recall and discriminate the
sequence of critical performance elements of selected dives?
3. How does videotape intervention affect subjects capability to accurately recall and discriminate the sequence of critical performance elements of selected dives?
4. Do analytic skills developed through graphics and videotape training on selected dives generalize to dives not included in the training protocols?
5. How accurately do subjects diagnose which performance elements should initially be corrected prior to intervention?
6. How does graphics intervention affect subjects capability to accurately diagnose which performance elements should initially be corrected?
7. How does videotape intervention affect subjects capability to accurately diagnose which performance elements should initially be corrected?
8. Do diagnostic skills developed through graphics and video training on selected dives generalize to dives not included in the training protocols?

Significance of the Study

This study examined affects of graphic and videotape training protocols on acquisition of analytic
and diagnostic skills of novice diving coaches. Subjects were trained in the analysis and diagnosis of four fundamental dives: forward dive straight, back dive pike, inward dive tuck, and forward dive half twist straight. After completion of the training protocols, subjects were tested to determine if skills learned through the protocols could be generalized to similar dives: forward dive tuck, reverse dive pike, and inward dive straight.

Results of this study will provide knowledge relative to the training of analytic and diagnostic skills for novice diving coaches. The effectiveness of graphics and video interventions for skill analysis and diagnosis will be shown. Information will be provided on novice coaches ability to generalize analytic and diagnostic skills across trained and untrained dives.

Information obtained from this study will provide the diving community with knowledge concerning verbal and visual identification skills, identification of major errors, and diagnostic ability of novice diving coaches prior to and after skill analysis training. Data from this study will provide information which can be used to revise the training package. After revisions, the package could be developed into
self-paced instructional protocol to assist in training skill analysis to beginning coaches.

**Limitations of the Study**

Limitations of this study affect the extent to which results can be generalized.
1. This study was limited to undergraduate students enrolled in a springboard diving class, water safety instruction classes, men's and women's collegiate swimming and/or diving teams, physical education major's and staff members from the Peppe aquatic center.
2. The study was limited to four diving skills:
   a) forward dive straight
   b) back dive pike
   c) inward dive tuck
   d) forward dive half twist straight
3. The pretest, probe, intervention, two posttests, and generalization videotapes included films of junior and senior high school students, college athletes, and elite senior divers from the Columbus area.

**Assumptions of the Study**

The following are assumptions for this study:
1. Ability to analyze sport skill is measurable.
2. Critical performance elements that comprise a sport skill can be defined, observed, and measured.
3. Experts used to confirm critical performance elements, check instructional phases, and rate performance assessment tests were elite national divers with experience in coaching.

4. Divers used for the video were a representative sample of athletic performance.

**Definition of Terms**

For this study, the following definitions have been included:

**Baseline** - Original data served as the objective basis or baseline by which to evaluate changes observed in behavior following intervention (Cooper, Heron & Heward, 1987).

**Closed skill** - A skill performed in a stable environment. Diving is a closed skill and will be the focus of this study.

**Critical performance element** - A selected movement important to a sequence of movements. When combined, critical performance elements form a successfully performed sport skill (Halverson, 1987)

**Diagnosis** - When observing sport skills, it is the process of identifying the cause of the discrepancy between correct and incorrect execution and determining which error should be intervened upon in order to improve learner performance (Hoffman, 1982).
Discrimination - Determining if a critical performance element was performed correctly or incorrectly.

Generalization - Transfer of learned skills to other behaviors, settings, or subjects.

Graphics training protocol - Use of diagrams and pictures to teach skill analysis.

Intervention - Systematic introduction of independent variables.

Major errors - Errors that cause major flaws in individual’s execution of their performance.

Multiple baseline research design - "A method of analyzing the relationship between the independent variable and the acquisition of a successive approximation or chain sequence. Data for the baseline condition is collected in intermittent measurements, or probes, to provide the basis for determining whether behavior change has occurred prior to intervention" (Cooper, Heward, & Heron, 1987).

Skill analysis - The process in which the teacher or coach systematically observes the response of students and on the basis of that observation identifies discrepancies between actual and desired response characteristics (Hoffman, 1977 p.1).

Sport skill - An advanced level of a fundamental skill that is used in a selected sport. Sport skills used
for this study included forward dive straight, back dive pike, inward dive tuck, and forward dive 1/2 twist straight.

**Trained dive** - One of the four dives included in the training protocols: forward dive straight, back dive pike, inward dive tuck, and forward dive half twist straight.

**Training protocol** - A package of materials including study sheets, pictures, worksheets, and use of videotape.

**Untrained dive** - Dives not included in training protocol. Generalization dives included forward dive tuck, reverse dive pike, and inward dive straight.

**Verbal identification** - Ability to recall and produce a permanent record of the critical performance elements and common errors of a sport skill.

**Video intervention** - Use of video to teach skill analysis.

**Visual analysis** - Ability to visually differentiate between correct critical performance elements and errors that occurred within the major components.

**Visual identification** - Ability to accurately recognize critical performance elements and common errors during execution of the skill.
CHAPTER II

Review of The Related Literature

Literature relative to this investigation will be discussed under seven content areas: (a) effects of physical education professional preparation on skill analysis proficiency, (b) ability to perform in relation to skill analysis proficiency, (c) teaching and coaching experience in relation to skill analysis proficiency, (d) pedagogical kinesiology, (e) specialized training for developing skill analysis proficiency, (f) programmatic research on skill analysis at The Ohio State University, and (e) the next step in developing skill analysis proficiency.

Effects of Physical Education Undergraduate Professional Preparation on Skill Analysis Proficiency

Skill analysis is the process of teachers/coaches systematically observing student responses of their students and on the basis of that observation, identifying discrepancies between actual and desired response characteristics.
Ultimately, information that is collected is reduced to a set of verbal responses which can be used to provide feedback to learners about their response (Hoffman, 1977 p. 1).

Since one of the major roles of physical educators and coaches is to improve student skill performance level, it is essential that they are able to analyze skill. In the past, skill analysis training of physical education teachers and coaches was assumed to be acquired through course work in kinesiology, biomechanics, sports skill courses, coaching courses, and advance skill experiences. Research however has caused teacher educators to question this assumption (Armstrong, 1977: Armstrong & Hoffman, 1979; Biscan & Hoffman, 1976; Girardin & Hanson, 1967; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983; Osborne & Gordon, 1972).

Hoffman and Sembiante (1975) investigated differences in analytic ability between baseball and softball coaches with no formal training in physical education (n=15), teachers with formal sports training, but no coaching experience (n=16), and a control group that had no training experience in either coaching or physical education (n=4). Prior to the study all
subjects were tested for vividness of imagery and visual imagery control. Subjects were then tested on skill analysis ability by viewing a prototype of a successful batter four times followed by viewing ten additional performances of batting. Subjects were asked to determine if the batters were similar or different from the prototype. The same procedure was repeated for a novel task. A Scheffe's post hoc test showed significant differences between groups with coaches scoring significantly higher than teachers or the control group on analyzing batting performance. There were no significant differences between physical education teachers and the control group on analytical ability. No differences were found between the three groups for analysis of the novel skill. Results from this study indicated that baseball experience was more beneficial for analyzing skill than training received in physical education teacher preparation. Results from this study question the assertion that kinesiology and biomechanics courses produce generic skill analysis ability.

Similar results relative to preservice and inservice physical education teachers trainees skill analysis proficiency were found by Biscan and Hoffman
The purpose of this study was to investigate whether physical educators possess special ability in skill analysis and if so whether this skill could be generalized. Three groups of subjects used for this study were: experienced physical education teachers (n=21), undergraduate physical education students enrolled in a biomechanics course (n=21), and regular classroom teachers (n=21). The average years of teaching experience was three for the physical education teachers and ten for the classroom teachers. Subjects viewed two identical performances of a prototype cartwheel which was then compared to ten other cartwheel performances. The same procedure was repeated with a novel skill. Results showed that veteran physical education teachers (X=6.52) and undergraduate students (X=7.71) had the advantage over the classroom teachers (X=4.38) when analyzing the cartwheel. There were no differences between the three groups when analyzing the novel skill.

Data from these two studies support Locke’s (1972) notion that undergraduate professional preparation for physical education teachers does not develop competency in skill analysis (Biscan & Hoffman, 1976; Hoffman & Sembiante, 1975). Biscan and Hoffman (1976) suggested
that weaker performances by physical education teachers may have been due to the fact that the importance attached to development and maintenance of analytical proficiency diminishes as teachers move further beyond their undergraduate training.

It has also been suggested that skill analysis proficiency is related more to experience and extent of exposure to visual stimuli related to specific skills rather than to general analytical schemes traditionally used by kinesiologists (Biscan & Hoffman, 1976; Hoffman & Sembiante 1975; Whiting, 1972).

**Ability to Perform in Relation to Skill Analysis Proficiency**

"For any given skill the teacher with the analytic advantage seems to be the one who has performed, practiced and studied specific components of that skill" (Locke, 1972 p.382).

Along with kinesiology and biomechanics courses physical education majors are required to take a variety of skill courses. Requiring teachers and coaches to develop minimal mastery of sport skill is thought to enhance their ability to teach those skills to students. The relationship between performance experience and sport skill analysis proficiency has been investigated.
Girardin and Hanson (1967) were among the first to investigate the relationship between ability to perform a sport skill and ability to analyze and diagnose errors of that skill. Subjects for the study were 32 male physical education majors. Each subject was given a knowledge test on mechanical performance and a skills test on eleven gymnastic stunts. Subjects were then asked to view a film and analyze the 11 stunts. Results showed a moderately significant correlation between both performance ability (r=.49) and mechanical performance knowledge (r=.51) and there relationship to diagnostic ability. There was no significant correlation found between performance ability and knowledge of mechanical performance (r=.33).

Armstrong (1977) investigated ability of subjects to analyze skill of a novel dance after exposure at varying levels of experience. Thirty subjects were drawn from volunteers from faculty and physical education students at a university. Subjects were randomly assigned to one of three groups: Group one practiced the model skill (10x’s) and similar skill (20x’s), Group two practiced the model skill only (30x’s), and Group three practiced only the similar model skill (30x’s). Each subject participated in a
four phase training session followed by a test of analytic ability. Subjects were asked to evaluate the performance of the critical elements for the skill for twenty filmed examples. Results failed to support the hypothesis that extent of performance experience and analytic ability are positively related. When examining these results consideration must be given to how the researchers defined performance experience. Only thirty trials of the skill from the group to which the subjects were assigned made up the performance experience for this study.

Similar results were revealed by Osborne and Gordon's (1972) study on performance skill in tennis and accuracy in analyzing tennis skill. Ninety male college students from a beginning tennis class were tested on their ability to rate six specific critical elements for the forehand tennis stroke. Subjects were grouped high, medium, and low according to their performance level on the forehand stroke which was judged by a panel of experts. One tennis player was filmed performing 16 forehand strokes demonstrating both correct and incorrect performances of the six critical elements. Subjects were divided into two groups, one rated the six elements while the other
group rated the elements and received feedback after each component. Results showed that subjects skill level did not affect overall ability to accurately analyze the forearm tennis stroke. All subjects were more capable of identifying correct over incorrect movements.

Results from studies investigated the relationship between sport experience and proficiency in analyzing sport skills have shown conflicting findings (Armstrong, 1977; Girardin & Hanson, 1967; Osborne & Gordon, 1972). Consideration must be given to actual performance experience subjects in the studies had obtained. Subjects in all three studies were novices in the sports.

In a follow up session of their previous study, Osborne and Gordon (1972) tested two other groups of subjects. A group of varsity tennis players (n=12) and a control group (n=12) with no tennis experience were tested. Both groups received the rating but no feedback intervention. Results revealed that the control group performed similarly to groups tested from the beginning tennis class. While varsity tennis players demonstrated no higher accuracy ratings than the other groups, they were better at identifying incorrect movements.
Harari (1986) investigated the relationships between subjects' content specific knowledge and the clinical diagnosis process in gymnastics. Subjects with varying degrees of gymnastics background were given a knowledge test and a visual skill analysis test. Subjects included; elite college gymnasts, inservice teachers, physical education majors, and subjects with a former competitive background in gymnastics. Gymnasts and former gymnasts performed significantly better on the knowledge test. A high correlation was found between knowledge of gymnastics and visual skill analysis. Subjects with competitive gymnastics background and teaching skills were significantly better at visual analysis than the other groups. Findings from this study indicated that skill analysis performance is a function of experience and familiarity with the subject matter. Research should continue in this area to determine the affects that advance or elite sports experience has on proficiency of sport skills analysis.

**Teaching and Coaching Experience in Relation to Skill Analysis Proficiency**

It is frequently assumed that teaching and coaching experience will automatically make an
individual more proficient at analyzing and diagnosing sport skills. Even if not properly trained during their undergraduate preparation, the assumption is that repetitiveness of curricula for physical education teachers and specificity of skills observed by a coach will improve skill analysis proficiency over time. Research however has shown conflicting and surprising results relative to teaching and coaching experience and proficiency in analyzing and diagnosing sport skills.

Results from Hoffman and Sembiante (1975) showed that baseball and softball coaches with an average of five years of coaching experience demonstrated significantly higher scores in analytic ability than physical education teachers or the control group. Results also revealed no significant differences between physical education teachers and teachers with no softball experience or training in physical education (control group).

In a similar study Biscan and Hoffman (1976) reported conflicting results in relation to physical education teachers' ability to analyze skills. Both physical education teachers and undergraduates in a biomechanics course showed superior ability to analyze
a cartwheel when compared to junior high school classroom teachers. However, results also showed that no significant differences between the three groups and their ability to analyze a novel skill.

A study investigating error detection proficiency was conducted using 40 professional tennis teachers with an average of 7.2 years teaching experience and 40 undergraduate physical education students (Armstrong & Hoffman, 1979). Subjects from each group were randomly assigned to one of four groups representing the type of information subjects received about the skill attempt: 1) performer competence information present/performance outcome information present (PCIP-POIP), 2) performer competence information present/performance outcome information absent (PCIP-POIA), 3) performer competence information absent/performer outcome information present (PCIA-POIP), and 4) performer competence information absent/performer outcome information absent (PCIA-POIA). Initial testing included a brief training session to establish a minimal criterion level of familiarity for the forehand stroke, 12 performance errors, and ground rules for determining presence of errors. Subjects were tested on 15 different examples of right handed players executing the forearm pass.
Subjects error detection scores were determined by subtracting the total number of incorrect responses from the total number of possible responses. Although results were minimal, a three-way ANOVA demonstrated that experienced teachers were more highly skilled at detecting common errors than were undergraduate students. No significant main effects were demonstrated for performance outcome information or performance competence information. Further analysis demonstrated two types of errors were committed. "Misses" occurred when a subject failed to include an error when it actually occurred in the performance. "False alarms" were errors indicated by subjects as occurring that did not occur in the performance. Researchers noted that experienced tennis teachers demonstrated fewer false alarms than inexperienced teachers.

More recently Imwold and Hoffman (1983) conducted a study investigating the relationship of teaching and coaching experience in gymnastics and accuracy of perceptual recognition and visual observation of a gymnastic skill (front handspring). Subjects included specialists (gymnastic coaches n=20) with an average of 8.6 years of experience, generalists (physical
education elementary and secondary teachers n=20) with an average of 5.4 years of experience, and novices (undergraduate physical education students n=20). The front handspring was broken down into four parts: hurdle step, hand placement, flight, and landing. Subjects were asked to identify two, three, or four of these components when viewing 13 films of the skill. Results revealed that specialists scored significantly higher (54%) than did generalists (47%) or novices (46%). The researchers were alarmed that physical education teachers who teach gymnastics at least once a year were no better at analyzing the gymnastic skill than the novice group having not received any gymnastics training. The elementary and secondary physical education teachers who made up the generalist group may not have taught the front handspring to their classes due to the difficulty level of the skill. This may indicate that the generalist group may not have been any more familiar with the front handspring than were the novices.

Research findings suggest that coaches are more accurate at diagnosing selected sports skills than physical education teachers (Armstrong & Hoffman, 1979; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983). It
would seem that coaches who deal primarily with one sport would be more proficient at analyzing skills used in that sport and more accurate when providing prescription for remediation. While physical education teachers and control groups were more capable of identifying correct elements of skills, coaches and those with more content knowledge were more capable of detecting errors (Armstrong, 1979; Harari, 1986; Imwold & Hoffman, 1983). Surprisingly, coaches in the Imwold & Hoffman study (1983) were only minimally better at skill diagnosis than the physical education teachers or control group. Results also suggest that coaches give appropriate information to their athletes only fifty percent of the time.

Skill proficiency of physical education teachers demonstrated conflicting results (Biscan & Hoffman, 1976; Hoffman & Sembiante, 1975; Imwold & Hoffman 1983). None of the groups tested were able to generalize skill analysis proficiency to unfamiliar tasks. Two hypothesis have been drawn relative to the training physical education teachers receive and how this affects skill analysis ability when teaching. First, training developed during physical education undergraduate programs diminishes as teachers move out into the field (Biscan & Hoffman, 1976; Hoffman &
Sembiante, 1975). A more realistic but harsher possibility is that the training used by physical education teacher preparation programs to develop skill analysis proficiency does not develop the appropriate skills for analysis of sports skills.

Skill analysis is seen as an essential vital skill for physical education teachers and coaches (Hoffman, 1977; Locke, 1972), yet research has shown that effective training in developing proficiency in skill analysis is lacking in preparation programs. While a positive relationship was shown to exist between skill analysis ability and teaching experience, coaching experience, or performance experience (Armstrong & Hoffman, 1979; Biscan and Hoffman, 1976; Girardin & Hanson, 1967; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983) results have demonstrated only minimal differences between experts, physical education teachers, and control groups with no experience. Results of studies investigating the relationship between physical education undergraduate training programs and skill analysis proficiency of physical education teachers and coaches has led to the realization that new means need to be sought to develop these skills. While research has not provided the
answers on how physical educators and coaches analyze skills, results indicate that what has been done relative to training has not been effective.

**Pedagogical Kinesiology**

Hoffman has been the leader in the study of applied sport skill analysis and has offered a number of suggestions for improving the training of skill analysis proficiency in physical education preparation programs. Through his writing and research, Hoffman (1974, 1977, 1982) has provided physical educators with some guidelines to assist in developing sport skill analysis through 'pedagogical kinesiology'. His guidelines suggest that:

1. The process of skill analysis should be practiced in a field-based or micro-teaching setting.
2. The main focus of skill analysis should be on the learner's motor response and the manner in which the teacher observes, analyzes, and responds to learners about their performance.
3. During the observation phase of a skill, teachers should have a set of criteria or critical performance elements associated with the successful attainment of the skill.
4. Teachers must be systematically trained to discriminate between correct and incorrect responses.
5. A vocabulary of summary labels and vivid pictures should be developed by teachers to transmit meaningful information to the learner about performance.

6. Instrumentation for assessing competence in observation, analysis, and prescription of a sport skill is an important key in the development and maintenance of skill analysis proficiency.

As a result of Hoffman's suggestions and through other research and literature (Stadulis, 1972) on skill analysis a number of skill analysis training techniques have been developed and tested. Urlich (1977) was among the first to produce a training module to teach skill analysis proficiency, a module on analytic proficiency of the golf swing. The module, which utilized stop action, slow motion, regular speed, and split screen audiovisual material demonstrating both correct and incorrect performances of the golf swing, was tested over a three year period with subjects who were enrolled in required golf courses. While no formal testing was conducted, students were questioned and reported that they enjoyed the GSED more than self-paced instructional groups.

Other models have been developed as a means to improve skill analysis proficiency (Barrett, 1983;
Brown, 1982; Fredrick, 1977; Hoffman, 1982; Kelly, 1990; Martin, 1981; Melville, 1983; Mielke & Morrison, 1985; Vanderson, 1979). While some of these models specialized in a specific sport; golf, basketball-jump shot, gymnastics, and swimming, others attempted to generalize and referred to movement categories. Kinesiology has provided the framework for some of these models (Brown, 1982; Mielke & Morrison, 1985) while critical components of skills were the reference point used for analysis of sport specific models (Martin, 1981; Vanderson, 1979). Checklists, templates, videotapes, and interactive videodiscs were recommended for use as a means of teaching and training skill analysis proficiency. Urlich (1977) and others suggest inclusion of correct exemplars for the analyzer to use as an ideal comparison model. Also included are incorrect examples or lists of errors that may frequently occur. While the models differ depending on the focus and procedures for training they all concur that skill analysis is a skill that is of crucial importance to the field of physical education.

Specialized Training for Developing Skill Analysis Proficiency

A number of studies have begun to investigate enhancing analytical skills through specialized

Using standing long jump, Hoffman and Armstrong (1975) were among the first to investigate effects of training on conditions of performance error identification. Eighty-six physical education majors were subjects for this study and were randomly assigned to one of four groups: 1) Correct-this group observed correct performances of the standing long jump; 2) Verbal-subjects were given only a verbal description of correct performance of the standing long jump; 3) Correct-error- subjects observed the correct jumping performance and observed errors; and 4) Control- this group observed an irrelevant film of throwing. Prior to the study all subjects were tested on two different mental imagery tests. For testing, subjects observed 12 films of the standing long jump and answered yes/no questions about the eight item criteria for correct performance. Mean scores for the initial error identification test were determined. Results showed that the means for the Verbal \( X = 35.80 \) and Correct-error \( X = 36.06 \) were significantly higher
than the Correct only (X = 34.81) and the Control (X = 32.64) groups. Scores remained stable in a three week retention test. Findings from this research suggest that the use of both correct and incorrect examples will aid in developing sport skill analysis proficiency.

Beveridge and Gangstead (1984) investigated effects of systematic analytic instruction and relationship between teaching experience, gender, and selected factors involved in qualitative skill analysis. Subjects were 31 experienced teachers and 29 undergraduates. The Utah Skills Analysis Test was administered prior to and at the completion of 30 hours of training. This test measures two components of the analytical process: 1) short term retention of observed motor responses and 2) knowledge of correct motor patterns.

Training involved a ten week unit which included in class analytic exercises. Instructional videotapes illustrating both correct and incorrect performances of sport skills were organized into common movement patterns. During instruction, emphasis was placed on proper description of the skill attempt which served as the target for analysis, how the identified observed
<table>
<thead>
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<th>Action</th>
<th>Follow Through</th>
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<td>Body weight</td>
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<td>Trunk action</td>
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<td>Head Action</td>
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<td>Action of Legs</td>
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<td>Action of Arms</td>
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<td>Impact/Release</td>
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</table>

Used by Beveridge and Gangstead (1984)
performance from the correct performance, and prescription of prioritized instructional strategies for correction of performance errors. A specific observational model was developed to direct students' attention towards the temporal aspects of performance. Skills were analyzed in phases: preparation, action, and follow through. Mean scores on each dependent variable were computed and revealed that a significant pre to post-test gain in perceptual performance was demonstrated for the entire sample. Results supported previous research relative to teaching and coaching experience which suggests a slight advantage for skill analysis proficiency (Armstrong & Hoffman, 1979; Biscan and Hoffman, 1976; Girardin & Hanson, 1967; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983).

The same observational model was used in a similar study undertaken by Gangstead and Beveridge (1984). A pretest posttest experimental design with a control group was used to investigate a methodological approach to skill analysis instruction. Subjects included 40 randomly selected undergraduate physical education majors who were randomly assigned to either the experimental or control group. The experimental group received approximately 36 hours of instruction three
times per week for eight weeks. Methodology included videotape and live performance of sport skills with both correct and incorrect performances. The observational model was used to guide students in analyzing various sport skill attempts. Again the Utah Skill Analysis Test was administered prior to and after the intervention. The control group received no formal instruction between the times they were administered the tests. T-test analysis demonstrated significant differences between experimental and control group performances. The investigators suggested that the model may have influenced the experimental subjects to selectively attend to relevant body movements and may have enabled them to control a mental image of the motor skill allowing them to remember more details about the performance. This study began to validate a specific analytic instructional strategy designed to improve skill analysis proficiency in physical education majors.

Gangstead (1984) continued to investigate the effectiveness of three basic approaches used for sport skill analysis instruction. Dependent variables for her study included two analytic tasks of interest: visual retention of overarm throwing performance and
knowledge of correct overarm throwing technique.

Ninety-one undergraduate physical education students were assigned to one of the three approaches or the control group. All subjects were required to achieve competency on written criteria for the overarm throw prior to intervention. The control group used the standing long jump. The observational model group received verbal instruction on the analytical processes associated with the observational model. The correct-error group received a checklist of errors which occur in beginning throwers and the correct only group received further visual demonstration of the criteria for the overarm throw. Further verbal and visual demonstrations of the standing long jump were provided to the control group. Total treatment times for all groups was four hours. A subtest of the overarm throw from the Utah Skill Analysis Test was used to test subjects during pre and post-tests. The observational model group performed significantly higher than the other three groups for visual retention. Results of the knowledge test demonstrated that the observational model group and the correct-error group performed significantly higher than did the correct only or the control group. Once again...
this study supports the need for skill analysis training to be incorporated into teacher preparation programs. While the observational model showed the most gains in skill analysis proficiency, all methods resulted in improved performance.

Continued research focusing on skill analysis instruction has been undertaken by Morrison and Reeve (1986; 1989). Their first study investigated the effectiveness of instructional videotapes in teaching elementary education majors to analyze throwing, catching, striking, and the soccer instep kick. All tapes showed children performing correct and incorrect performances of the skills. Content of the tapes included sequential critical teaching cues and common errors associated with the skill. The videotapes were approximately forty minutes in length. Subjects included 84 undergraduate elementary education majors who were randomly divided into three groups. One group viewed a video tape on throwing, catching, and striking. Another group viewed a video tape on the soccer instep kick and the remaining group served as a control group. Two days after subjects viewed the instructional tapes they were shown a test tape of children throwing, catching, and striking. Subjects
were asked to determine if the skills were performed correctly or incorrectly, if they chose incorrect they were to select cues which would correct the performance. A one-way analysis revealed significant differences among groups. The throwing, catching, and striking group \( (X = 78.56) \) differed significantly from the soccer instep kick group \( (X = 72.83) \) and the control group \( (X = 74.56) \). Although the training methodology differed, this study added further empirical support for specific instructional training to develop analytical skill proficiency (Beveridge and Gangstead, 1984; Gangstead, 1984; Gangstead and Beveridge, 1984).

Morrison and Reeve (1989) again investigated the effectiveness of instructional units for throwing, catching, and striking on qualitative skill analysis. Subjects included 29 undergraduate physical education students assigned to a either good-examples-only group or good-and-bad examples group. Pre and post-tests were administered using the Group Embedded Figures Test to measure perceptual style and a qualitative analysis test. Results showed that both groups benefited from instruction, however the group that was shown good examples only, benefited more than the group which was
shown both good and bad examples. These results conflict with previous studies which found groups receiving both correct and incorrect examples improved more on skill analysis than groups which received correct only (Gangstead & Beveridge, 1984; Hoffman & Armstrong, 1975).

Programmatic Skill Analysis Research at The Ohio State University

Skill analysis training has been one focus of programmatic research at the Ohio State University (Kniffen, 1985; Halverson, 1986; Morton, 1989; Wilkinson, 1986). Kniffen (1985) investigated physical education majors' ability to analyze student performance of selected sport skills as a result of individualized videotape instruction. The videotape instruction included correct and incorrect performances of a cartwheel, standing long jump, batting, and throwing. A study guide was given to all subjects after viewing the videotape. Nine undergraduate physical education majors were tested prior to and after the videotape intervention. They were tested on ability to verbally identify critical elements of selected sports skills and visually discriminate those elements as correct, incorrect, or missing when viewing
selected students. Kniffen (1985) reported that videotape instruction was an effective pedagogical tool to facilitate sport skill analysis. It appeared that ability to recall critical elements acted as a cue to focus attention on those features of the sport skill performance which required discrimination. Subjects' ability to analyze skill was also successfully generalized to "real" school settings.

Wilkinson (1986) developed the Volleyball Skill Analysis Visual Discrimination Training Program to teach skill analysis of the forearm pass, overhead pass, and overhand serve to undergraduates enrolled in a required volleyball course. Three groups composed the sample: experimental, class control, and control group. The experimental group and class control group were stratified by skill level. The experimental group received the training package, while the class control group received pictures only. Three components were included in the training package: stop action, slow motion, and normal speed. Both efficient and inefficient skill attempts were displayed at all three speeds. While all groups improved results showed that the Volleyball Skill Analysis Visual Discrimination Training Program produced significant improvement in
verbal identification and visual analysis. High skilled subjects in all groups improved more than low skilled subjects.

In a follow up study one year after the completion of the Volleyball Skill Analysis Visual Discrimination Training, all subjects still in the physical education teacher education program were tested on maintenance of the three volleyball skills (Wilkinson, 1990). Result’s revealed disappointing findings. Subjects ability to accurately analyze critical elements decreased from 73% to 49% for the forearm pass, 72% to 35% for the overhand pass, and 58% to 34% for the overhand serve. As mentioned earlier, skill analysis training once developed diminishes if it is not used frequently (Biscan & Hoffman, 1976; Hoffman & Sembiante, 1975; Imwold & Hoffman, 1983).

Halverson (1987) also reported significant improvement of verbal identification and visual discrimination for the experimental group. Intervention included worksheets, direct instruction, peer tutoring, and performance practices. The experimental group demonstrated a significant functional effect for both verbal and visual discrimination of the selected sports skills;
headstand, back straddle roll, cartwheel, and standing long jump. Scores for the control group were not significantly different from scores earned by the regular instruction group. Students did not learn skill analysis of sport skills by merely participating or watching the critical element demonstration. Cartwheel was the most difficult skill to analyze due to the rapidness of the movement.

Use of photographs and videotape, were both part of a skill analysis training program developed by Morton (1989). Six pre-physical education majors took part in the progressive self-paced instructional program. Verbal and visual identification of four sports skills were tested and trained. Generalization of skill analysis of the same skills performed by older students was also tested. Subjects were required to meet a criterion after the photographic protocol and prior to the videotape training protocol. Skills that were analyzed included the over arm throw, standing long jump, place kick, and running. Morton (1989) reported that photographic intervention resulted in a substantial gain in subjects analytic proficiency. Criterion tests after the video protocol showed transfer of analytic proficiency to moving performances.
and increased error detection performances. Subjects were able to successfully generalize analytic skills to older students.

The Next Step in Developing Sport Skill Analysis Proficiency

Skill analysis research has shown that proficiency can be developed through specialized training. While some training techniques have viewed skill analysis as a generic skill others have specialized with specific sports. Developing and deciding how to include skill analysis training into teacher preparation programs is still to be determined. Hoffman (1974) suggested that skill analysis training involve a process that includes three hierarchical steps: 1) learner skill is observed, 2) learner response is evaluated, and 3) diagnosis of the response allows feedback to be provided relative to the skill attempt.

In Hoffman's model (1974), ability to provide accurate feedback to the learner is preceded by accurate observation and diagnosis. The skill of observing is essential in skill analysis and needs to be taught to teachers. Barrett (1983) identified three basic components of observing: deciding what to observe, planning how to observe, and knowing what
factors influence ability to observe. A number of tools have been used to enhance observation as a part of skill analysis training protocols. Use of critical elements, checklists, and observational models have been included to guide observation. All of these techniques assist in giving the teacher specific points to look for rather than being overwhelmed by trying to observe the entire skill.

Evaluating or discriminating has also been attended to in many of the training protocols by including both correct and incorrect examples of skill performance. In addition to having an ideal image of what the skill should look like when it is performed correctly, teachers/coaches also need to observe common performance errors. Skill analyzers must be able to discriminate when a skill is performed incorrectly and be able to pinpoint specifically how the skill deviated from the ideal performance.

The final step in the process of skill analysis is diagnosis or prescription; determining what information should be given to the learner to improve skill performance. Assuming that providing appropriate feedback to the learner is the ultimate goal of skill analytic training, research needs to focus on connecting the link between analysis and diagnosis.
Further study in the area of skill analysis is warranted. There is strong agreement indicating the need for skill analysis training of physical education teachers and coaches. A number of studies have begun to demonstrate that observation and analysis skills can be systematically taught. Continued research needs to focus on the most effective means of developing skill analysis training protocols in terms of time, content, and practical application of skill analysis training to 'live' settings.
CHAPTER III
Methods and Procedures

Chapter III is divided into nine sections: selection of subjects, critical performance element and error selection, development and construction of the diving skill analysis training protocols: graphics and videotape, accuracy of independent variable, test videotape construction, performance assessment construction, reliability of dependent variable, research design, and data collection procedures.

Selection of Subjects

Subjects for this study were volunteers solicited from: men's and women's intercollegiate swimming and diving teams, basic physical education diving classes, physical education majors' classes, and the Peppe aquatic center. Nine men and six women volunteered to participate in return for one credit hour of Physical Education 693 independent study, Spring 1990. Purpose, procedures, and time commitment of the study were discussed at an initial meeting and subjects were asked to sign a contract (see Appendix A). All fifteen subjects agreed to participate. They were also asked
to read and sign the informed consent form established by the human subjects committee of The Ohio State University (see Appendix B).

During this initial meeting subjects completed a personal background profile which included information about the subjects previous training, and teaching, or coaching experiences in diving and other sports. Data from this profile is summarized in Table 2. One subject dropped-out after the third session due to time constraints.

All subjects were given an entry level test which included terms, basic knowledge, and a visual test on recognition of dives. Subjects were required to obtain 90% on the entry test in order to begin the study. The purpose of the test was to ensure subjects had a basic knowledge about diving in order for them to understand the training protocol. Seven of the 15 subjects did not obtain 90% on their first attempt of the entry level test. A brief handout and video were administered as a remedial measure for those who did not meet the criteria. All subjects were successful at reaching 90% criteria on the second testing.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Diving Related Performance</th>
<th>Experience Coach/Teach</th>
<th>Skill Analysis Background</th>
<th>Other Related Experiences</th>
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<td>coach age group swim</td>
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Critical Performance Element and Error Selection

The four dives that were selected for this study included: the forward dive straight, back dive pike, inward dive tuck, and forward dive half twist straight. These dives were chosen because they represent four of the five required dives used in springboard diving. They are also basic dives which build a foundation of skills for learning more complicated dives. These dives included the three positions used in diving (tuck, pike, and straight) and represented dives which novice divers would be learning.

A review of literature was conducted to identify commonly cited critical performance elements and common errors for each dive (Batterman, 1968; Billingsley, 1965; Fairbanks, 1963; Goldberg, 1986; Moriarity, 1959; Peppe, 1961). Critical performance elements represent parts of the skill performance which experts reported are necessary to successfully execute the dive. They also suggested these critical performance elements are the key points that should be the focus on when analyzing the dive. Common errors were the major errors effecting the mechanical rather than the aesthetic performance of the dive.

Due to the lack of current literature on springboard diving a panel of experts were surveyed to
provide consensus on selection of critical performance elements, and common errors, and the diagnostic process they use when coaching diving. The panel of experts included two Olympic diving coaches, two national age group coaches, and two division III collegiate coaches. The panel reviewed a critical elements list for the selected dives with categories of major and minor errors for each critical performance element. Experts were asked to confirm or reject the researcher's suggestions and delete or add any elements or errors they felt were incorrect or omitted. Experts were also asked what errors they would correct first when working with beginning divers. Five of the six coaches indicated they would intervene on the error which occurred first in the dive.

Information gathered from surveying the panel of experts was used to develop the training and testing protocols for this study. Six critical performance elements were identified, assigned brief labels to describe them, and listed in chronological order. A list of errors were determined for each of the critical elements and the philosophy for diagnosis established. Before final decisions were made on the choice of critical performance elements and errors used to
develop the training protocols, the training materials were pilot tested with a class of beginning diving students. This took the form of a one-to-one and small group formative evaluation. Materials were also reviewed by an expert in the field.

Labels were assigned for each of the six critical performance elements for the four selected dives. These labels were used throughout the study. Subjects were expected to recall and list these labels in chronological order and use them to assist in analyzing and diagnosing dives. Major errors were also categorized according to elements selected for each dive. Due to the nature of the sport and the simplicity of dives chosen, there were some similarities of the critical performance elements and major errors (see Appendix C).

**Development and Construction of The Diving Skill Analysis Training Protocol:**

**Graphics and Videotape**

Information gathered from the panel of experts was used to develop the training protocols for the independent variable. The independent variable was a training package that was designed to develop analytical and diagnostic skills for diving. The package included two protocols, graphics and videotape.
Graphics Package

The focus of the graphics package was to teach subjects the six critical performance elements and to train subjects to discriminate correct from incorrect diagrams of various parts of the dive. The construction of the graphics protocols followed the same procedures for each of the four dives (see Appendix D).

The first step in developing the graphics package involved diagraming the six critical performance elements and major errors that occurred during these steps. The diagrams were then included in an individualized training protocol. The major focus of this protocol was to develop discrimination skills.

The first part of the protocol showed the sequence of six critical performance elements performed correctly. Worksheets were included for subjects to practice listing the six critical performance elements in order of occurrence. Section two focused on discriminating correct and incorrect diagrams of the six critical performance elements. Again worksheets were used to practice discriminating correct and incorrect examples of each critical performance element. If the diagrams were incorrect subjects were asked to list the errors which occurred.
At the conclusion of the graphics protocol a graphics test was given. Subjects were required to obtain 80 percent on the test before progressing to the videotape instructional protocol. The graphics test involved viewing three different dives which contained both correct and incorrect diagrams of the critical performance elements. For each dive, subjects were to list the six critical performance elements, determine if they were correct or incorrect, and if incorrect list specific errors that had occurred. On one occasion a subject had to repeat the graphics protocol.

Packages were duplicated to allow more than one subject to work with material at one time. Subjects were given up to one hour to complete the package.

Videotape Instructional Package

The first step in developing the video training protocols involved videotaping a variety of divers performing the four selected dives and three dives that would be used for generalization. Subjects serving as models for the videotape were from the following teams: the collegiate team at Ohio State University, two high school teams, and an age group program from the Columbus area. The researcher asked permission of the coaches to solicit volunteers from the teams to attend
a videotaping session at the The Ohio State University. Permission was secured from the university to use the facilities. A total of thirty-eight divers were videotaped during ten different sessions. A portable Panasonic VHS color videotape recorder was used to videotape all students. The camera was secured to a tripod and positioned in line with the end of the one-meter diving board fifteen to twenty feet away. Only the side view of the dive was filmed, because this is how diving is judged, making this the most common view. In an attempt to obtain a clear picture for the use with slow motion in the training video the shutter speed of the camera was set on 1000.

Prior to taping, subjects were instructed to perform three trials of each selected dive. Selected dives included: forward dive straight, back dive pike, inward dive tuck, forward dive half twist straight, forward dive tuck, reverse dive pike, and inward dive straight. If subjects could not perform or did not feel comfortable attempting one of the dives they were told to go on to the next dive. If an error was made or subjects wanted to repeat a performance they were allowed to do so. Divers were asked to set the board and then wait for the researcher’s command before
performing the dive. Following the dive, the camera was left on focusing on the water for ten seconds allowing enough blank tape between divers for future videotape editing. The type of dives and number of dives to be performed were listed on a chart for the divers to refer to as they performed.

Following filming, the researcher reviewed and coded each individual response. Three aspects of performance were addressed for each response; whether critical performance elements were performed correctly or incorrectly, major errors that occurred, and diagnosis of the dive.

Raw videotape footage was edited by the researcher onto four 45 minute training videotapes. Training tapes contained three sections a) critical performance elements, b) errors, and c) diagnosis. All sections included use of normal and slow motion videotape footage and a number of practice exercises directing subjects to pause the tape and record answers.

The first section, critical performance elements, showed an elite diver correctly performing all six critical performance elements for the selected dive. Subjects were asked to verbally repeat critical performance elements while viewing the video tape,
pause the tape to record critical performance elements on paper, and practice viewing the correct performance of the critical performance elements at normal speed.

Section two focused on major errors for novice divers which occurred during performance of the six critical performance elements. This section involved viewing which portion of the dive that was the focus of the critical performance element and then viewing examples of errors which occurred during each critical performance element. After examining the second, fourth, and sixth critical performance elements a practice exercise was administered. These practice exercises had subjects focus on the previous two critical performance elements they had just viewed (1&2, 3&4, 5&6). They were asked to view a dive twice at normal speed and then record if the critical performance elements were performed correctly or incorrectly. If performance was incorrect subjects were to list specific errors which occurred. The dive was then shown in slow motion with correct responses. The same procedures were repeated for another example.

At the conclusion of this section a final review was provided using two different dives. Each dive was shown twice at normal speed with subjects asked to view
the dives and determine if the six critical performance elements were performed correctly or incorrectly. If elements were performed incorrectly, subjects were asked to record the major errors which occurred. Again, after the subject responded the dive was shown in slow motion providing the correct responses for that dive.

The final section focused on diagnosis; a description of the process of choosing the error that should be corrected first in a dive. The technique used for developing diagnostic skills was determined by the panel of experts who also had developed the critical performance elements. This diagnostic technique taught that the error to be corrected first in a dive was the first major error to occur during the divers' performance. There appears to be a sequence effect in diving, when an error occurs early in the dive it usually effects following actions of the dive. In this section of the video, a number of dives were examined in which cause and effect of early errors were highlighted in an effort to develop diagnostic skill. Again a series of dives were presented so that subjects could practice diagnosis. A final practice exercise was administered which included subjects viewing a
dive, listing the six critical performance elements in order of occurrence, determining if they were correct or incorrect, if incorrect listing specific errors, and determining which error would they correct first.

**Accuracy of the Independent Variable**

To determine the effectiveness of the diving skill analysis training packages, two types of formative evaluations were conducted. A one-to-one evaluation was done with an observer who had been a competitive diver in high school. The purpose of the one-to-one was two fold. First, to gather information about the effectiveness and clarity of the diving skill analysis training package. Second, to check the accuracy of the diagrams and videotape used to represent correct and incorrect critical performance elements and errors of the four selected dives.

This independent observer and the researcher examined all four training packages. Any parts of the graphics or videotape protocols that were unclear to the observer were discussed. The observer mentioned that the common error "ducking head" which occurs in the sixth critical performance element had been omitted. The researcher agreed and included this error in all of the training protocols. When other
disagreements arose while viewing the video, stop action and slow motion were used to resolve the conflict. Correctness or incorrectness was easily decided in stop action. No other major disagreements were found and the independent observer confirmed that the diagrams and videotape footage used for the training protocols were appropriate.

The second type of formative evaluation was conducted with small groups. Six students from a beginning diving class were administered two of the four training protocols following identical procedures to be used in actual testing. Again the purpose was to determine clarity and effectiveness of the interventions. A result of this evaluation was to clarify the directions and format of the answer sheets to make it easier for the subjects to follow.

Once appropriate changes were made as a result of the one to one and small group formative evaluations, a final accuracy check was conducted with an independent observer who was an elite diver and a high school coach. The expert verified the accuracy of the diving skill analysis training packages by viewing all four graphics protocols and taking the graphics test for each of the dives. In the four graphics tests,
agreement between the researcher and observer was 90% on the presence or absence of critical performance elements represented by the 72 diagrams making up the four dives. Interobserver agreement for errors was 87.5%. Percent of errors identified is directly related to the percent of critical elements discriminated as correct or incorrect. The researcher referred the observer to the graphics package to show which diagrams were misdiagnosed. After reviewing the graphics package the observer agreed 100% with the researcher that the diagrams were correct.

This observer also viewed the content of the four instructional videotapes using slow motion and stop action when necessary. Accuracy of the diving skill analysis videotapes was verified by the independent observer.

Performance Assessment Construction
Baseline and Probe

Videotape used for collecting baseline data was edited from the performance tapes taken during ten sessions at The Ohio State University. Four examples of forward dive straight, back dive pike, inward dive tuck and forward dive half twist straight were selected to make up the performance assessment test. Performances were different than those shown in the instructional video.
During editing, the performances were recorded three consecutive times at normal speed with thirty seconds of blank tape in between each dive. Since the purpose of testing sessions was to obtain accurate information, subjects were allowed to stop the tape if more time was needed to record their answers.

Execution of each dive showed examples of dives being performed with all critical elements correct, all elements incorrect, and a combination of correct and incorrect performances. Prior to each dive, an audio recording identified the diver and number dive being viewed. After completion of the test tape it was reviewed for production errors.

Generalization

The generalization video contained performance examples of the four trained dives, but examples that had not been previously encountered. These examples tested what was referred to as trained generalization. Subjects also viewed performances of three dives (forward dive tuck, reverse dive pike, and inward dive straight) that had not been a part of the training protocol. These examples tested what was referred to as untrained generalization. Three examples of each of the seven dives were shown, making a total of 21 dives
on the generalization tape. Each performance was recorded three times at normal speed with thirty seconds of blank tape between each dive. Testing procedures were the same as those used for the assessment performance test.

Reliability of the Dependent Measures

A reliability check was conducted for the dependent measures. As stated by Cooper, Heward, and Heron (1987) and Siedentop (1976) reliability is defined as the degree to which independent observers agree upon what they see and evaluate. Two elite divers who were also high school coaches reviewed and analyzed the performance assessment and generalization tapes. These experts verified the analysis and diagnosis of all 37 dives from the two tapes. The following formula was used to establish interobserver agreement:

\[
\text{Interobserver} = \frac{\text{Agreements}}{\text{Agreement} + \text{Disagreements}} \times 100
\]

Two experts were used to establish interobserver agreement for critical performance elements, errors, and diagnosis of the testing videotapes. Use of stop
action and slow motion were allowed to determine the presence or absence of questionable components. Accuracy of errors and diagnosis depended upon the accuracy of discrimination of critical performance elements. There were a total of 96 visual intervals of critical performance elements on the performance assessment test. Of these 96, four were in disagreement between independent observer 1 and the researcher which resulted in a 95.8% agreement score for critical performance elements and 89.7% agreement for errors. Observer 2 obtained a score of 94.1% agreement for critical performance elements and 88.5% for errors. On the generalization tape there were 126 visual intervals and 136 errors. Agreement scores were 92.6% for critical performance elements and 88.8% for errors for observer 1. Observer 2 obtained an interobserver agreement score of 94% for critical performance elements and 87.7% for errors.

Where disagreements occurred the researcher and experts reviewed the tapes using slow motion and stop action. One hundred percent agreement was reached by the experts and the researcher prior to development of the master key which was used to score subject's answers. Specific major errors for each dive were
re-evaluated and diagnosis was calculated. The experts rank ordered the top three errors which should be corrected first in order to improve execution of the dive.

Research Design

The single subject research design used for this study was a multiple probe baseline across skills. In this design probes provided the basis for determining whether changes within the skill have occurred prior to the intervention and whether changes remained during post intervention.

The basic design has three key features:

1) an initial probe is taken to determine the subject's level of performance on each behavior in the sequence;

2) a series of repeated baseline measures is taken on each step prior to training on that step; and

3) after criterion level performance is reached on any training step, a probe of each step in the sequence is taken to determine whether performance changes have occurred in any other steps (Cooper, Heward, & Heron, 1986 p. 210).

The experimental logic of the multiple baseline design is explained by Baer, Wolf, & Risley (1968):
In the multiple-baseline technique, a number of responses are identified and measured over time to provide baselines against which changes can be exalted. With these baselines established, the experimenter than applies an experimental variable to one of the behaviors, produces a change in it, and perhaps notes little or no change on the other baselines. If so, rather than reversing the just produced change, he instead applies the experimental variable to one of the other, as yet unchanged responses. If it changes at that point, evidence is accruing that the experimental variable is indeed effective, and that the prior change was not simply coincidence. The variable then may be applied to still another response, and so on. The experimenter is attempting to show that he has a reliable experimental variable, in that each behavior changes maximally only when the experimental variable is applied to it (p. 94).

The independent variable included four diving skill analysis training packages designed to develop analytic and diagnostic skills for the four selected dives. The training packages included two protocols, graphics, and videotape.
The dependent variables addressed in this study were identification and visual discrimination of the six critical performance elements, and identification of major errors with selection of which should be intervened upon first in order to improve the diver’s performance.

In this study, independent variables were sequentially introduced to four separate dependent analytic and diagnostic behaviors. Induction was expected to occur due to similarity of some of the critical elements. The study was replicated across 14 subjects for four selected dives. Skill analytic and diagnostic skills were also tested across similar dives.

Data Collection Procedures

Ten sessions were scheduled for subjects to respond to various protocols. Session one was used for baseline measurement, while session ten tested generalization. The remaining eight sessions were spread over a four week period. Two sessions per week were scheduled and used to complete one dive per week. The first session of each week required subjects to go through the graphics package, pass the graphics test, and then take the performance assessment test. Session two required
subjects to complete the videotape instruction and again take the performance assessment test. This procedure was repeated for all four of the selected dives over a four week period. Training packages were systematically introduced, one per week, to each subject in the following order: forward dive straight, back dive pike, inward dive tuck, and forward dive half twist straight.

The performance assessment test was given to all subjects for all four dives. All dive examples were shown three times at regular speed. Four forward dives, four back dives, four inward dives, and four forward dive 1/2 twists made up the assessment test. For the baseline measure, subjects viewed all sixteen dives. For the remaining testing periods selected dives were used from this tape to probe and test performance of various dives studied.

After viewing each dive, subjects were asked to record their answers to the following statements:
1. Identify the six critical performance elements and list them in order of occurrence.
2. Determine if the critical performance elements were performed correctly or incorrectly.
3. If performed incorrectly, list the specific errors which occurred.
4. Determine which error to correct first in the dive. Answers were recorded on the answer sheets (see Appendix E) which provided a permanent research product which were graded against expert's responses. Data gathered from each of the fourteen subjects provided a baseline of each subjects' analytic and diagnostic skill level.

Analytic skill was measured by the subjects' written identification and visual identification of the critical performance elements. Failure to write an element by leaving a space blank was marked as an error. Following the intervention, subjects responses had to conform to key phrases used in the graphics and videotape training protocols. No partial credit was given; responses were either correct or incorrect. In scoring visual identification, an error was recorded if the discrimination choice was incorrect or if there was no critical performance element listed. Each dive was scored on a zero to six basis, for both the written and verbal identification. A perfect score for correct identification equaled six points.

Diagnostic skill was measured by calculating the percentage of errors identified correctly by the subjects for each of the dives viewed. Subjects
response to the question which error should be corrected first was compared to the experts' rating of the top three errors to be corrected. Grading for this section was zero to three points. Subjects received three points if they selected the experts first choice, two points for second choice, and one point for the third choice. Zero points were received if subjects listed answers that were not identified by the experts. Diagnostic scores were calculated for all dives whether critical performance elements were listed or not.
Figure 1. Flow Chart of Research Methodology.
CHAPTER IV
Analysis of the Data

Chapter four is divided into the following sections: a) reliability of data collection procedures, b) procedures and rational for visual inspection of the data, and c) research questions.

**Reliability of Data Collection Procedures**

Reliability checks were conducted by random selection of scoring sheets from two sessions for each subject. Score sheets for four subjects were randomly chosen from the generalization test. One hundred and forty score sheets out of a total of six hundred and two were checked by an independent observer. Instructions on procedures for recording scores were given to the independent observer. An unmarked copy of the answer sheet was used by the observer to confirm accuracy of the permanent product. Reliability was determined for verbal and visual identification of the critical performance elements, detection of specific errors, and diagnosis (selection of the error to be corrected first).
The investigator and the independent observer agreed on 625 of 630 responses for the forward dive straight (99.2%). For the back dive there were 720 agreements for 736 responses (98.3%). Responses for the inward dive were 748 with 734 agreements (91.8%). The independent observer and investigator agreed upon 614 out of 622 responses for the twist dive (98.7%).

The same procedures were used to check four subjects data for the generalization session. The independent observer and investigator agreed upon 987 of 1006 answers (98.1%).

Disagreement was usually due to different but similar wording used for errors and diagnosis. At times a different phrase would be used by the subjects to describe an error which occurred in the dive. Since the reliability observer was unfamiliar with diving and the training intervention the phrase was assumed to be incorrect. The same disparity occurred during scoring for diagnosis.

**Procedures and Rational for Visual Inspection of Data**

In single subject research, data is displayed on graphs and visually inspected to make judgements concerning the significance of the experiment.
visual analyst must take several factors into consideration when judging graphic data. In order to determine if changes were due to interventions, graphs must be analyzed within and across conditions using statistical properties of data that are amenable to visual analysis. These properties include variability, levels, and trends of data. Variability is "the extent to which measures of behavior under the same environmental conditions differ from one another" (Cooper, Heward, & Heron, 1987 p.131). Level refers to the central tendency of the data within conditions, and then compared across conditions. Trend refers to the path or direction of the data set. All three of these components must be taken into consideration when analyzing data visually.

Data for the fourteen subjects are displayed on multiple baseline graphs. A line graph is used to display visual identification data for each subject (see Appendix F). Percent of major errors identified correctly by subjects is displayed on bar graphs (see Appendix G). A cumulative graph is used to present subjects' agreement with experts choices of errors to be corrected first (see Tables 2-16). Table 3 reports the number of critical performance elements verbally
identified for each session by the fourteen subjects. Tables 4-7 provide mean scores for critical performance element identification for each of the four dives for baseline, after graphics and video interventions, and during generalization sessions. For the same sessions, Tables 8-11 show percentage of major errors identified correctly by each subject.

The experimental design for the study was the multiple probe baseline across behaviors. Behaviors included the forward dive straight, back dive pike, inward dive tuck, and forward dive half twist. The study was replicated for each of the fourteen subjects. Generality of analytic and diagnostic skills was tested with unfamiliar stimuli of trained dives and untrained dives which included: forward dive tuck, reverse dive pike, and inward dive straight.

**Research Questions**

**Question 1:** How accurately do subjects identify and visually discriminate the sequence of critical performance elements of selected dives prior to intervention?

**Verbal Identification**

Baseline data for verbal identification were low and stable for all subjects (see Tables 3-7). There were six critical performance elements for each dive.
Mean baseline scores for the forward dive was 0.2, with a range of 0.1 - 1.0, and a modal score of 0.0. Mean baseline performance for the back dive was 0.5, with a range of 0.0 - 1.0, and a modal score of 0.0. Mean baseline performance for the inward dive was 1.0, with a range of 0.4 - 1.6, and a modal score of 1.2. Mean baseline performance for the twist was 2.2, with a range of 1.1 - 2.7, and a modal score of 2.4. The low scores and relative absence of variability indicate that the subjects could not verbally identify critical performance elements prior to intervention.  

Discussion

For verbal responses to be judged correct during baseline, they had to be recognizable in comparison to the critical performance elements. Subject responses were typically vague and general. Some subjects could not identify six performance elements. Written responses varied from vague descriptions of form to the results of dives rather than their technical performance elements. Examples of elements identified in baseline were "high in air" and "take-off". The critical element that was most often correctly identified during baseline for all dives was "vertical entry".
Table 3
Verbal identification of critical performance elements
(6 is equal to 100%)

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Table 4
Mean number of critical performance elements correctly identified for the forward dive straight

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention Graphics Verb/Vis</th>
<th>Intervention Video Verb/Vis</th>
<th>Generalization Same Verb/Vis</th>
<th>Generalization Similar Verb/Vis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0 0.0</td>
<td>6.0 4.5</td>
<td>6.0 5.0</td>
<td>6.0 5.0</td>
<td>6.0 4.5</td>
</tr>
<tr>
<td>2</td>
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<td>6.0 4.7</td>
<td>6.0 4.5</td>
<td>4.0 3.3</td>
</tr>
<tr>
<td>3</td>
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<td>6.0 3.2</td>
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</tr>
<tr>
<td>4</td>
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</tr>
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</tr>
<tr>
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</tr>
<tr>
<td>12</td>
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<tr>
<td>14</td>
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<td>4.0 5.0</td>
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<tr>
<td>Group Mean</td>
<td>0.2 0.4</td>
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<td>6.0 4.4</td>
<td>5.9 4.2</td>
<td>4.7 3.7</td>
</tr>
</tbody>
</table>
Table 5
Mean number of critical performance elements correctly identified for the back dive pike

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention Graphics Verb/Vis</th>
<th>Intervention Video Verb/Vis</th>
<th>Generalization Same Verb/Vis</th>
<th>Generalization Similar Verb/Vis</th>
</tr>
</thead>
<tbody>
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<td>6.0 3.6</td>
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<td>6.0 4.3</td>
<td>3.0 2.3</td>
</tr>
<tr>
<td>3</td>
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<td>6.0 4.3</td>
<td>5.0 3.0</td>
</tr>
<tr>
<td>4</td>
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<td>6.0 3.6</td>
<td>5.0 2.0</td>
</tr>
<tr>
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<td>6.0 5.3</td>
</tr>
<tr>
<td>8</td>
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<td>6.0 4.7</td>
<td>6.0 4.7</td>
<td>5.0 3.0</td>
<td>6.0 5.3</td>
</tr>
<tr>
<td>9</td>
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<td>6.0 4.5</td>
<td>3.0 3.0</td>
<td>3.0 1.6</td>
</tr>
<tr>
<td>10</td>
<td>1.0 1.0</td>
<td>6.0 3.5</td>
<td>6.0 5.7</td>
<td>6.0 4.3</td>
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</tr>
<tr>
<td>11</td>
<td>0.6 0.6</td>
<td>6.0 4.2</td>
<td>6.0 5.7</td>
<td>6.0 4.3</td>
<td>5.0 4.6</td>
</tr>
<tr>
<td>12</td>
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<td>6.0 5.0</td>
<td>5.0 3.6</td>
<td>6.0 5.0</td>
</tr>
<tr>
<td>13</td>
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</tr>
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<td>4.0 3.6</td>
</tr>
<tr>
<td>Group Mean</td>
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<td>6.0 4.3</td>
<td>6.0 4.9</td>
<td>5.3 3.8</td>
<td>5.1 4.0</td>
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</tbody>
</table>
Table 6
Mean number of critical performance elements correctly identified for the inward dive tuck

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention</th>
<th>Generalization</th>
<th>Generalization</th>
</tr>
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<td>Video Verb/Vis</td>
<td>Same Verb/Vis</td>
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</tr>
<tr>
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<td>6.0 4.3</td>
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<tr>
<td>3</td>
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</tr>
<tr>
<td>4</td>
<td>1.2 0.9</td>
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<td>4.0 3.6</td>
</tr>
<tr>
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<td>6.0 5.0</td>
</tr>
<tr>
<td>7</td>
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<td>6.0 4.2</td>
<td>6.0 4.6</td>
</tr>
<tr>
<td>8</td>
<td>1.4 0.8</td>
<td>6.0 4.2</td>
<td>6.0 4.2</td>
<td>5.0 4.6</td>
</tr>
<tr>
<td>9</td>
<td>0.6 0.6</td>
<td>6.0 4.0</td>
<td>6.0 4.2</td>
<td>5.0 4.0</td>
</tr>
<tr>
<td>10</td>
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<td>6.0 4.5</td>
<td>6.0 3.7</td>
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<tr>
<td>11</td>
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<td>6.0 4.7</td>
<td>6.0 4.6</td>
</tr>
<tr>
<td>12</td>
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<td>6.0 3.7</td>
<td>6.0 4.2</td>
<td>6.0 5.6</td>
</tr>
<tr>
<td>13</td>
<td>1.6 1.1</td>
<td>6.0 4.7</td>
<td>6.0 5.0</td>
<td>5.0 3.6</td>
</tr>
<tr>
<td>14</td>
<td>1.2 1.1</td>
<td>6.0 3.7</td>
<td>6.0 4.0</td>
<td>4.0 3.3</td>
</tr>
<tr>
<td>Group Mean</td>
<td>1.0 0.7</td>
<td>5.9 4.0</td>
<td>6.0 4.2</td>
<td>5.4 4.3</td>
</tr>
</tbody>
</table>
Table 7
Mean number of critical performance elements correctly identified for the forward dive one-half twist straight

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe Verbal/Visual</th>
<th>Intervention Graphics Verb/Vis</th>
<th>Video Verb/Vis</th>
<th>Generalization Same Verb/Vis</th>
<th>Generalization Similar Verb/Vis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.4 2.0</td>
<td>6.0 4.7</td>
<td>6.0 5.0</td>
<td>6.0 4.6</td>
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</tr>
<tr>
<td>2</td>
<td>2.0 1.4</td>
<td>6.0 4.5</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>2.5 1.4</td>
<td>6.0 3.5</td>
<td>6.0 3.0</td>
<td>6.0 4.6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.2 1.7</td>
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<td>6.0 4.0</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>1.1 0.8</td>
<td>6.0 4.7</td>
<td>6.0 4.5</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>7</td>
<td>2.5 1.8</td>
<td>6.0 4.4</td>
<td>6.0 5.0</td>
<td>6.0 4.6</td>
<td></td>
</tr>
<tr>
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<td>6.0 4.0</td>
<td>6.0 4.7</td>
<td>6.0 4.3</td>
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</tr>
<tr>
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<td>4.0 2.3</td>
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<tr>
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<td>5.0 3.7</td>
<td>4.0 2.0</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2.4 1.3</td>
<td>6.0 4.2</td>
<td>6.0 5.2</td>
<td>6.0 3.3</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2.1 1.3</td>
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<td>6.0 4.0</td>
<td>6.0 5.0</td>
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<tr>
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<tr>
<td>14</td>
<td>2.2 1.5</td>
<td>6.0 3.2</td>
<td>6.0 3.0</td>
<td>6.0 4.3</td>
<td></td>
</tr>
<tr>
<td>Group Mean</td>
<td>2.2 1.5</td>
<td>6.0 4.3</td>
<td>6.0 4.3</td>
<td>5.7 4.0</td>
<td></td>
</tr>
</tbody>
</table>
Experience in diving and academic course work related to skill analysis had no effect on baseline performance. Eight subjects had diving experience, ranging from amateur to intercollegiate levels. Three subjects had taken courses in skill analysis or kinesiology. None of these subjects performed significantly better than subjects with no experience or course work.

**Visual Identification**

Baseline data for visual identification was low and stable for all subjects. Group data for visual identification are shown in Tables 4 - 7. Individual data is shown in line graphs and can be found in Appendix F. The lack of variability among subjects in visual identification warranted showing the group means rather than the individual data sets. There were six critical performance elements for each dive. Mean baseline performance for the forward dive was 0.4, with a range of 0.0 - 1.0, and a modal score of 0.0. Mean baseline performance for the back dive was 0.4, with a range of 0.0 - 1.0, and a modal score of 0.6. Mean baseline performance for the inward dive was 0.9, with a range of 0.2 - 1.1, and a modal score of 1.1. Mean baseline for the twist was 1.5, with a range of 0.8 - 2.0, and modal scores of 1.4 and 2.0. The low scores
and relative absence of variability indicates that the subjects could not visually identify critical performance elements prior to intervention.

Discussion

If a critical performance element was not verbally correctly identified no points were awarded for visual identification of that element. In order to accurately discriminate visual stimuli, an observer must be able to verbally identify what they are looking for (Halverson, 1987; Hoffman, 1977; Kniffen, 1985; Morton, 1989; Wilkinson, 1986). Due to inability to verbally identify the six critical performance elements subjects were unable to make correct visual identifications of whether these elements were performed correctly or incorrectly.

Question 2: How does the graphic intervention affect subjects capability to accurately recall and discriminate the sequence of critical performance elements of selected dives?

Verbal Identification

Introduction of the graphics package caused an abrupt increase in level for performance scores of verbal identification for all subjects (see Tables 3-7). Mean performance score after graphics intervention for the forward dive was 5.9, with a range
of 5.0 - 6.0, and a modal score of 6.0. Mean performance for the inward dive was 5.9, with a range of 5.0 - 6.0, and a modal score of 6.0. All subjects scored 100% for both the back and inward dives. Twelve of fourteen subjects obtained 100% verbal identification for all four dives after graphics intervention. Four of fourteen subjects were able to maintain 100% verbal identification for all dives during post intervention phases of the study. Performance scores for verbal identification show a significant increase for all four dives as a result of the graphics intervention.

Discussion

For verbal scores to be recorded as correct, subjects had to write verbatim critical performance elements learned during intervention. Written responses were maintained at significantly higher levels than during baselines.

Introduction of the graphics interventions resulted in an induction effect on two to three critical elements in the remaining baselines. Similar induction effects were observed for 13 of 14 subjects. One critical performance element of the forward dive, vertical stretch, was the same for all four dives, resulting in an induction effect. Further induction
occurred during the twist baseline as a result of the forward dive intervention due to same first and second critical performance elements for both dives. Similarity of the first critical element between the back dive and inward dive also caused induction effects. Induction was expected due to the repetition of critical performance elements used to describe the four dives which were included in the study. Despite the induction, the effects of the intervention were clear and significant.

Visual Identification

Although visual identification was more variable than verbal identification, performances were significantly higher than during baselines (see Table 4-7 and Appendix F). Mean performance score for the forward dive was 3.7, with a range of 1.7 - 5.2, and a modal score of 3.7. Mean performance for the back dive was 4.3, with a range of 3.2 - 5.5, and a modal score of 4.7. Mean performance for the inward dive was 4.0, with a range of 3.2 - 5.2, and modal scores of 3.7 and 4.0. Mean performance for the twist dive was 4.3, with a range of 3.2 to 5.5, and modal scores of 4.0, 4.7, and 5.0. The increase in scores indicate that subjects performance of visual identification improved significantly after graphics intervention.
Discussion

For visual responses to be judged correct after graphics intervention, verbal identification had to be recorded correctly. Varying degrees of response for visual identification could be due in part to the nature of the sport which involves high speed movements. Similar results were reported by Halverson (1987), Kniffen (1985), and Morton (1989). High speed movements make it difficult to observe critical performance elements. In a questionnaire given to subjects upon completion of the study, four subjects mentioned that they wish they could have viewed test dives in slow motion once before they viewed them at regular speed.

Another reason for varying responses could be due in part to misinterpreting the explanation of errors taught in the graphics package, which in turn caused subjects to respond incorrectly when viewing the video. One example of this was the error, low hurdle, which was in both the forward and twist dive interventions. Low hurdle was described as being lower than one foot off the board. It appeared that subjects had a difficult time referencing this point and tended to mark average hurdles as being incorrect due to low height.
A greater amount of variability between subjects scores was shown for the forward dive than for the other three dives. This may be due to the forward dive being the first intervention that subjects encountered.

The varying skill level of divers on the assessment test may also have affected subjects ability to discriminate errors. Errors were more noticeable when lower skilled divers performed the dives.

Although varying effects were demonstrated by subjects, the graphics package appeared to significantly increase analytic performance levels for all dives. Induction effects occurred for visual identification as well as for verbal identification. These results provide further support for the use of low cost, low technological interventions as an effective means to train skill analysis proficiency (Morton, 1989).

Question 3: How does the videotape intervention affect subjects capability to accurately recall and discriminate the sequence of critical performance elements?

Verbal Identification

Performance scores for verbal identification were 6.0 or 100% correct for all four dives for all subjects (see Tables 3-7).
Discussion

Verbal identification of critical performance elements were reviewed during the beginning section of the videotape intervention. Subjects were asked to repeat elements both verbally and written along with viewing a correct model. Critical performance elements were used throughout the video and subjects were required to write them down numerous times. Repetitiveness of seeing, hearing, and writing critical performance elements during video intervention may have resulted in the slight increase in performance from the graphics interventions.

Visual Identification

Performance scores for visual identification after videotape interventions were similar to those scores received after the graphics interventions (see Tables 4-7, and Appendix F). Mean performance score for the forward dive was 4.4, with a range of 3.5 - 5.0, and a modal score of 4.5. Mean performance score for the back dive was 4.9, with a range of 4.2 - 5.7, and a modal score of 5.5. Mean performance for the inward dive was 4.2, with a range of 3.5 - 5.0, and a modal score of 4.2. Mean performance score for the twist dive was 4.3, with a range of 3.0 - 5.5, and modal scores of 3.7, 4.0, 4.7, and 5.0. Improvement
over graphics mean scores for visual identification were demonstrated by 11 subjects for the forward dive, 11 subjects for the back dive, 9 for the inward dive, and 7 for the twist dive. Decrease of mean scores were demonstrated by 2 subjects for the forward dive, 4 subjects for the inward dive, and 7 subjects for the twist dive. Subjects performance on video interventions resembled performance after graphics intervention inferring that the video intervention can increase and/or maintain performance of visual identification.

Discussion

The video intervention gave subjects the opportunity to view the critical performance elements in motion. Stop action, slow motion, and regular speeds were all included as a part of the videotape intervention. Since all subjects received the graphics intervention prior to the video intervention the effectiveness of the video training alone can not be made.

A possible reason for a decrease in performance on the twist dive may be due to unclear explanations of the critical performance elements during the intervention. After the study was over, subjects
commented that the twist dive was difficult and confusing to understand. When viewing the video intervention subjects watched divers twisting to the right during the dive. The performance assessment tape had divers twisting to both the right and left. Due to lack of explicit description by the researcher when explaining critical performance elements for twisting, subjects recorded divers who twisted to the left as incorrect.

Question 4: Do analytic skills developed through graphics and videotape interventions on selected dives generalize to dives not included in the training protocols?

Verbal Identification

Verbal identification was maintained for generalization of trained dives (see Tables 3-7). Mean performance for the forward dive was 5.9, with a range of 5.0 - 6.0, and a modal score of 6.0. Mean performance for the back dive was 5.3, with a range of 3.0 - 6.0, and a modal score of 6.0. Mean performance for the inward dive was 5.4, with a range of 4.0 - 6.0, and a modal score of 6.0. Mean performance for the twist dive was 5.7, with a range of 4.0 - 6.0, and a modal score of 6.0. Maintenance of performance scores
indicate that verbal identification was generalized to new examples of trained dives.

Performance scores for verbal identification of critical elements for dives not included in the training were also high. Mean performance scores for the forward dive tuck was 4.7, with a range of 4.0 - 6.0, and a modal score of 4.0. Mean performance for the reverse dive pike was 5.1, with a range of 3.0 - 6.0, and a modal score of 6.0. Mean performance score for the inward dive layout was 4.4, with a range of 2.0 - 6.0, and a modal score of 5.0. Although performance scores were slightly lower than for trained dives, verbal identification of critical performance elements were demonstrated for untrained dives.

Discussion

Higher scores were expected for trained versus untrained dives. Identifying the critical performance elements for untrained dives required subjects to integrate critical elements learned during training. Subject one was able to correctly identify verbal labels for all dives tested in the generalization session.

Visual Identification

Performance scores were maintained for generalization of trained dives (see Tables 4-7, and
Appendix F). Mean performance score for the forward dive for visual identification was 4.2, with a range of 4.0 - 5.3, and a modal score of 4.0. Mean performance score for the back dive was 3.8, with a range of 3.0 - 4.6, and a modal score of 4.3. Mean performance for the inward dive was 4.3, with a range of 3.3 - 5.6, and a modal of 4.6. Mean performance for the twist was 4.0 with a range of 2.0 - 5.0 with a modal score of 4.6. Maintenance of performance scores from interventions to generalization of new examples of trained dives indicates that training had a generalizable effect.

Performance scores for visual identification of critical elements for dives not included in the training were also high. Mean performance scores for the forward dive was 3.7, with a range of 2.0 - 5.0, and modal scores of 3.3 and 3.6. Mean performance for the reverse dive was 4.0, with a range of 1.6 - 5.3, and a modal score of 5.3. Mean performance for the inward dive was 3.2, with a range of 0.6 - 5.6, and a modal score of 3.0. Generalizable effects of training were demonstrated by subjects analyzing untrained dives at similar levels as for trained dives.

Discussion

The strong performance of subjects when analyzing the critical elements of dives not included in the
training program indicates that some generalization of analytic skill had occurred. This suggests that dive-specific training on all dives might not be necessary for a general analytic skill to develop. If so, this would enhance the cost effectiveness of skill analysis training protocols.

Question 5: How accurately do subjects diagnose which performance element should be initially corrected prior to intervention?

Major Errors

Baseline data for major error identification were low and stable. Group data for error identification are shown in Tables 8 - 11. Individual data are shown in bar graphs and can be found in Appendix G. The lack of variability among subjects in error identification warranted showing the group means rather than the individual data sets. Mean percentage score for baseline of the forward dive was 1%, with a range from 0% - 7%, and a modal score of 0%. Mean baseline percentage for the back dive was 11%, with a range of 1% - 31%, and a modal score of 10%. Mean baseline percentage for the inward dive was 11%, with a range of 4% - 30%, and a modal score of 7%. Mean baseline percentage for the twist dive was 13%, with a range of
Table 8
Percentage of major errors identified correctly for the forward dive straight

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention Graphics</th>
<th>Video</th>
<th>Generalization Trained</th>
<th>Untrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7%</td>
<td>37%</td>
<td>59%</td>
<td>69%</td>
<td>58%</td>
</tr>
<tr>
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<td>0%</td>
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<td>53%</td>
<td>41%</td>
</tr>
<tr>
<td>3</td>
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<td>18%</td>
<td>44%</td>
<td>53%</td>
<td>33%</td>
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Group Mean Percentage 01% 20% 44% 53% 50%
Table 9
Percentage of major errors identified correctly for the back dive pike

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention Graphics</th>
<th>Intervention Video</th>
<th>Generalization Trained</th>
<th>Generalization Untrained</th>
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<td>10%</td>
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Group Mean Percentage

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<th>Intervention Video</th>
<th>Generalization Trained</th>
<th>Generalization Untrained</th>
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<td>53%</td>
<td>42%</td>
<td>40%</td>
</tr>
</tbody>
</table>
Table 10
Percentage of major errors identified correctly for the inward dive tuck

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention Graphics</th>
<th>Video</th>
<th>Generalization Trained</th>
<th>Generalization Untrained</th>
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</table>

Group Mean
Percentage 11% 34% 34% 44% 35%
Table 11
Percentage of major errors identified correctly for the forward dive one-half twist straight

<table>
<thead>
<tr>
<th>Subject</th>
<th>Baseline/Probe</th>
<th>Intervention Graphics</th>
<th>Intervention Video</th>
<th>Generalization Trained</th>
<th>Generalization Untrained</th>
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<td>24%</td>
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<tr>
<td>4</td>
<td>17%</td>
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<td>38%</td>
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<td>11</td>
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<td>12</td>
<td>14%</td>
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<td>72%</td>
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</tr>
<tr>
<td>14</td>
<td>7%</td>
<td>13%</td>
<td>2%</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Group Mean Percentages</td>
<td>13%</td>
<td>37%</td>
<td>43%</td>
<td>41%</td>
<td></td>
</tr>
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</table>
5% - 29%, and with modal scores of 10%, 14%, and 17%. The low scores and relative absence of variability indicate that subjects were not able to identify major errors prior to intervention.

Discussion

Major error identification was scored regardless of performance on verbal and visual identification. In order for responses to be marked correctly, they had to be recognizable compared to expert responses for the four dives. Subjects one and thirteen, who both had diving experience, obtained slightly higher scores during baseline than did other subjects. Induction did occur for all subjects upon introduction of interventions. Since, similar major errors occurred in all dives in the study, induction was expected.

Diagnosis

Poor baseline diagnostic ability was shown by low flat slope lines in the cumulative graphs prior to intervention (see Figures 2-15). Induction occurred during baselines for 9 of 14 subjects upon introduction of interventions.

Discussion

Responses for diagnosis had to be similar to those determined by experts. Subjects tended to record
Figure 2. Cumulative points for diagnosis for each dive type.
Cumulative Points for Diagnosis

Twist Dive  Inward Dive  Back Dive  Forward Dive
Subject three: Cumulative points for diagnosis for:

- Dive Inward Dive
- Dive Forward Dive
- Point Dive
- Inward Dive
- Back Dive
- Forward Dive

Graph showing cumulative points over different dives for subject three.
Figure 3: Cumulative Points for Diagnosis

- Twist Dive
- Inward Dive
- Back Dive
- Forward Dive
Cumulative Points for Diagnosis

Twist Dive

Inward Dive

Back Dive

Forward Dive

Figure 6.
Cumulative points for diagnosis for subject five.
Cumulative Points for Diagnosis

Twist Dive  Inward Dive  Back Dive  Forward Dive

Figure 7.
Cumulative points for diagnosis for subject six.
Cumulative Points for Diagnosis

Twist Dive

Inward Dive

Back Dive

Forward Dive

Figure 8. Cumulative Points for diagnosis for subject seven.
Figure 5: Cumulative Points for Diagnoses for

Subject Right

Cumulative Points for Diagnosis

Dive Types

Twist Dive

Inward Dive

Back Dive

Forward Dive

Subject Left
Subject none.

Cumulative Points for Diagnosis

1. Twist Dive
2. Inward Dive
3. Back Dive
4. Forward Dive

Diagram
Cumulative Points for Diagnosis

Subject Eleven.

Figure 32. Cumulative Points for Diagnosis for:
- Point Dive
- Inward Dive
- Back Dive
- Forward Dive
Figure 12: Cumulative Points for Diagnosis

Cumulative Points for Diagnosis

Twist Dive  Inward Dive  Back Dive  Forward Dive

Cumulative Points for diagnosis for subject twelve.
Cumulative Points for Diagnosis

Figure 14: Cumulative Points for Diagnosis for subject thirteen.
Cumulative Points for Diagnosis

Figure 15.
Cumulative points for diagnosis for subject fourteen.
general and vague answers for the major error to be corrected first and many times left the answer blank. Examples of errors identified in baseline were "straight legs", "height", and "entry". During the first session, the most common response was for remediation to an error which occurred during the entry.

Diving experience for subjects one and thirteen may have had an effect on their ability to transfer diagnostic skills to remaining dives. These two subjects demonstrated the greatest amount of induction during baselines of untrained dives. Experience therefore, may affect the ability of a subject to use training information and generalize that information more quickly than less experienced subjects.

Question 6: How does the graphics intervention affect subjects capability to accurately diagnose which performance elements should initially be corrected?

**Major Errors**

A significant level increase was apparent for all four dives after graphics intervention for 12 of 14 subjects (see Tables 5-8, and Appendix G). Mean percentage score for the forward dive was 20%, with a range of 7% - 51%, and a modal score of 18%. Mean
percentage for the back dive was 40%, with a range of 23% - 66%, and a modal score of 43%. Mean percentage for the inward dive was 34%, with a range of 7% - 60%, and a modal score of 28%. Mean percentage for the twist dive was 37%, with a range of 13% - 59%, and a modal score of 45%. An increase in scores from baseline measures indicate that the graphics intervention was functionally related to the change in level of performance for major error identification.

**Discussion**

Although the main focus of the graphics package was to train analytic skills, examples of common errors were provided as part of discrimination training. The elite diver obtained the highest percentage scores for all four dives after the graphics intervention.

**Diagnosis**

An increase in performance was demonstrated for 5 of 14 subjects for forward dive, 10 of 14 for back dive, 7 of 14 for inward dive, and for 7 of 14 for the twist dive after the graphics intervention (see Figures 2-15). The graphics intervention appeared to have a significant effect in diagnostic performance, overall 13 of the 14 subjects demonstrated an increase in diagnostic performance for one or more dives.
Discussion

The technique that was taught for diagnosis was to determine which major error occurred first in the dive. Due to similar errors which occurred between forward and twist dives, and back and inward dives, the increase in number of subjects improving performance for the inward and twist dives may be due in part to induction.

Differences were seen between subjects and between dives as to the extent that the graphics intervention produced increased performance levels of diagnostic skills. Subject one demonstrated the most significant improvement after the graphics intervention for all four dives. While subject nine showed no increase in performance level after graphics. Subject nine continued to record general answers for diagnostic responses.

Question 7: How does the videotape intervention affect subjects capability to accurately diagnose which performance elements should initially be corrected?

Major Errors

Data after video interventions demonstrate maintenance or a slight increase in performance for all subjects (see Tables 5-8, and Appendix G). Mean
performance score for the forward dive was 44%, with a range of 29% - 81%, and a modal score of 37%. Mean percentage for the back dive was 53%, with a range of 36% - 86%, and a modal score of 46%. Mean percentage score for the inward dive was 34%, with a range of 10% - 55%, and a modal score of 26%. Mean percentage score for the twist dive was 43%, with a range of 2% - 72%, and with modal scores of 45%, 51%, and 59%. Seven of the 14 subjects demonstrated an increase in performance for all four dives after video interventions. The high and stable scores indicate that subjects were able to maintain and/or slightly improve performance levels for major error identification after video interventions.

Discussion

Since all subjects viewed the video intervention after receiving the graphics intervention, the sole effectiveness of the video intervention can not be determined. The video intervention provided subjects with one example of each error shown in slow motion and regular speed. In a questionnaire filled out by subjects at the conclusion of the study, a number of subjects reported that they would have liked more time and examples for major error identification.
While all subjects improved their scores from graphics to video for the forward dive, 13 subjects increased their scores for the back dive, 7 for the inward dive, and 10 for the twist. Maintenance of percentage scores were shown by 1 subject for the back and inward dives, and 2 subjects for the twist dives. The elite diver, subject thirteen, obtained significantly higher scores for the forward (81%) and twist dives (72%) than other subjects and was among the highest scores for the remaining two dives.

Weaker performances for the inward dive may be due in part to the fact that the dives included in the assessment video contained more errors than for the other three dives. Also subjects usually recorded only one error per critical element. The dives used for the inward dive assessment contained more 'double errors' than any of the other three dives.

Diagnosis

Improvement of diagnostic skill was apparent after video interventions for 6 of 14 subjects for the forward dive, 8 subjects for the back and twist dives, and 7 subjects for the inward dive (see Figures 2-15). Data for five subjects showed an increase in slopes for diagnostic performance for all four dives after video interventions.
Discussion

The video intervention gave subjects the opportunity to view dives in slow and regular motion, along with diagnostic explanation of what and why an error should be corrected first. Again, subjects commented in the questionnaire that more examples and further explanation of diagnosis would have been helpful. From the data, it was apparent that failure to diagnose correctly was due to misdiagnosis, rather than the incorrect sequence of errors.

Differing effects were also demonstrated for diagnostic performance for subjects. Subject nine demonstrated no improvement during video training for diagnostic scores. This subject continued to record general answers for diagnosis, which in turn were marked as being incorrect. Best performances for diagnosis were shown by subject one and thirteen. Both these subjects had interscholastic diving experience and had taught or coached age group diving. Subject four, who also had experience coaching diving, demonstrated significant improvement and maintenance for diagnosis throughout intervention and post intervention phases of the study.
Question 8: Do diagnostic skills developed through the graphics and videotape training on selected dives generalize to dives not included in the training protocols?

Major Errors

Major error percentages for trained dives were maintained at similar levels that were acquired after interventions (see Tables 8-11, and Appendix G). Mean percentage for the forward dive was 53%, with a range of 30% - 69%, and a modal score of 53%. Mean percentage for the back dive was 42%, with a range of 10% - 65%, and a modal score of 35%. Mean percentage for the inward dive was 44%, with a range of 18% - 75%, and a modal score of 43%. Mean percentage for the twist dive was 41%, with a range of 14% - 61%, and a modal score of 52%.

Subjects were able to identify major errors for untrained dives at a similar level as for trained dives. Mean percentage score for the forward dive tuck was 50%, with a range of 33% - 66%, and with modal scores of 50% and 54%. Mean percentage for the reverse dive pike was 40%, with a range of 10% - 68%, and a modal score of 31%. Mean percentage for the inward dive straight was 35%, with a range of 4% - 73%, and with modal scores of 17% and 30%.
Discussion

The strong performance of subjects identifying errors of dives not included in the training program indicates that generalization of major error identification had occurred. This suggests that dive-specific training on all dives might not be needed in order to develop error discrimination skills.

Three subjects (one, twelve, and thirteen) who had interscholastic background in diving were most successful at generalizing major error identification to both trained and untrained dives. Generalization of major error identification performance may be enhanced by individuals who have performance experience.

Diagnosis

Diagnosis for trained dives demonstrated that performance was generalized for 8 of the 14 subjects for the forward dive, and for 11 subjects for the back, inward, and twist dives (see Figures 2-15). No generalization was demonstrated by subjects five or nine for any of the trained dives.

Diagnostic scores for untrained dives showed generalization for 10 subjects for the forward dive, 9 subjects for the reverse dive, and for 11 subjects for the inward dive. Again, no generalization was
demonstrated for subjects five or nine for any of the untrained dives.

Discussion

Weaker results demonstrated by subjects for the trained forward dive, may be due in part to the diagnostic errors occurring later than the first critical performance element. Also the assessment test for the forward dive had one dive with no errors, which gave subjects fewer chances to increase their performance scores.

Although it was expected for subjects to generalize to trained dives, noteworthy results were demonstrated by subjects for generalization to untrained dives. Seven subjects demonstrated diagnostic performance for all four trained dives and seven subjects demonstrated diagnostic performance for all three untrained dives. Three of these seven subjects (three, thirteen, and fourteen) demonstrated generalization of diagnostic performance for both trained and untrained dives. Subjects five and nine failed to record specific errors when diagnosing during the generalization session.
Even with the variation between dives and subjects the data support the conclusion that diagnostic skills can be generalized to both trained and untrained dives.
CHAPTER V
Summary, Findings, Discussion, and Implications

Summary

The purpose of this study was to investigate the effectiveness of graphic and video training protocols on analytic and diagnostic skills for teaching/coaching beginning diving. After training was completed, a final performance assessment examined the extent to which analytic and diagnostic skills generalized to trained and untrained dives. The design used for this investigation was a multiple probe baseline design, across four basic dives; forward dive straight, back dive pike, inward dive tuck, and forward dive one-half twist straight. Subjects for the study included fourteen volunteers who had an interest in swimming, diving, and/or physical education.

The study was conducted over a five week period which included ten sessions. An entry level diving test was administered to establish basic knowledge which would be needed to understand terms used in the interventions and performance assessment. After
successful completion of the entry test, baseline measures were determined. The performance assessment test asked subjects to verbally and visually identify critical performance elements, discriminate major errors, and diagnose which error to correct first for each of the dives observed. Graphics and video interventions were administered in a sequential fashion for all dives. The focus of the graphics protocol was on analytic skills, while the video protocol focused on diagnostic skills. Performance assessment tests were administered after each intervention. A generalization session was administered following completion of all training protocols.

Findings

1. Baseline performance levels for verbal and visual identification of critical performance elements were low and stable, so much so that the conclusion could be supported that these subjects could not identify or discriminate critical performance elements for these dives. Subjects with diving experience or course work in kinesiology did not perform significantly better than other subjects. Similar findings have been shown by Halverson, (1987), Kniffen (1985), Morton, (1989), and Wilkinson, (1986).
2. Baseline performance levels for discrimination of major errors and diagnosis of which error to remediate first were low.

3. Subjects who had competitive experience with diving showed slightly higher scores for major error identification during baseline. This finding indicates that divers with experience used the information they learned in graphics intervention better than did subjects without diving experience.

4. As was expected, induction occurred from interventions to untreated baselines when critical elements among dives were highly similar. Wilkinson, (1986) reported similar findings.

5. Induction occurred from interventions to untreated baselines for major error identification. This was expected due to similar major errors between dives.

6. Induction of diagnosis was shown by two subjects who had diving and coaching experience. These subjects were able to use the information they learned from the interventions better than subjects with no diving training.

7. Proficiency levels for analytic skills significantly improved after graphics intervention. Morton (1989) reported similar findings.
8. Improved levels of verbal and visual identification (analytic skills) obtained during graphics interventions were maintained after video training. This finding supports Morton (1989).
9. Performance scores for major error identification increased significantly after graphics intervention.
10. Video interventions maintained and increased major error performance scores obtained during graphics.
11. The elite diver obtained the highest percentage scores for major errors identified for three out of the four dives.
12. Varying levels of improvement were shown after graphics intervention for diagnosis. Thirteen of the fourteen subjects demonstrated diagnostic skills for one or more dives.
13. Diagnostic performance was maintained and/or improved from graphics to video interventions for the majority of subjects.
14. Analytic and diagnostic skills acquired through graphics and video interventions were generalized to new examples of trained dives and to examples of dives not included in training.
15. Diving experience did make a difference. Subjects with experience were able to use information gained
through training more effectively than those with no experience.

16. Training for diagnosis was not as effective as training for analysis with the method employed.

Discussion

Visual analysis of the multiple baseline graphs for each subject demonstrate effectiveness of both the graphics and video interventions. From the graphic intervention subjects were able to verbally and visually identify critical performance elements for all four dives at a fairly high rate. These results suggest that graphics training may be just as effective as video training for developing verbal and visual identification. These results support similar findings by Morton (1989).

The video intervention appeared to be most effective for training subjects to identify major errors and for diagnosis. Diagnostic performance varied across subjects and dives. Subjects who had a competitive background in diving demonstrated higher performances for major error identification. In a questionnaire that was administered after the study, a number of subjects suggested that they would have liked
to spend more time observing errors and practicing identification. Lack of proficiency of correct error identification related to subjects performance ability for diagnosis of errors to be corrected first. Subjects misdiagnosis were usually due to failure to identify the error, not improper sequence of what should be corrected. Giving subjects too much to look for could also have been a reason for varied results for diagnosis. During testing subjects viewed the same dive three times and then were asked verbally and visually to identify the critical performance elements, identify major errors, and determine which error to correct first.

More varied performances demonstrated for diagnosis may also be due to overload of information necessary to remember needed information. Teaching subjects both analysis and diagnostic skills at one time required them to memorize six critical performance elements and be familiar with fourteen to twenty errors per dive. In some cases subjects confused errors and placed them where they did not occur. It may be necessary for an individual to be able to observe and analyze a skill proficiently and consistently prior to teaching them how to diagnose.
The training method used in this study for diagnosis should also be questioned. Although significant results were demonstrated for diagnostic skills for some of the subjects, others resulted in variable and in some cases minimal performance. This research investigated training diagnostic skills for diving through the use of critical performance elements. The induction which occurred during baselines for dives suggests that within dives there may be similar components and errors which are generalizable for similar dives. Training diagnostic skills for diving may have been more effective by intervening with training protocols that dealt more with generic parts of a dive rather than critical performance elements. For example, interventions would focus on the approach, take-off, flight and entry. Although critical performance elements are essential for teaching diving, another means may need to be investigated to develop diagnostic skills which are more abrupt and consistent than those demonstrated in this study.

Experience did appear to have an influence on subjects' capability to analyze and diagnose dives. Subjects with experience in diving appeared to use
information gained from training more effectively than those with no experience. A possible reason for this may be that subjects who were familiar with the sport had an easier time understanding the information in the graphic and video training protocols. Also since they were familiar with terms and errors common to diving there was also less to memorize.

Results from this study also suggest that analytic and diagnostic skills need to be trained differently. The use of critical performance elements were effective for training analytic skills, but did not appear to be as effective for training diagnostic skills. Developing proficiency for analytic ability by obtaining criterion levels for verbal and visual identification of critical performance elements may be a prerequisite to developing diagnostic proficiency.

Implications for Future Research
The following implications are based on the findings of this study:
1. This study should be replicated using interventions that deal with common parts of dives (ex: approach, take-off, flight, and entry) rather than specific critical performance elements for each dive.
2. This study should be replicated training analytic skills for all dives prior to teaching diagnostic skills. A criterion level would have to be reached by subjects for analytic skill before they could go on to diagnostic training.

3. This study should be replicated with groups of high-skilled divers versus no experience in diving.

4. Relative effects of graphics and video interventions should be studied.

5. This study should be replicated with generalization into a 'live' setting.

6. This study should be replicated with generalization testing of more difficult dives used in diving. For example, dives which include somersaults and twists.

7. This study should be replicated with 'real' beginning diving coaches rather than subjects who had an interest in diving.

8. This study should be replicated with different sports skills.

9. An extension of this study, providing feedback, should be investigated. An additional intervention which involved clinical experience where subjects practiced analysis, diagnosis, and prescription should be included.
Implications for Teacher Educators in Physical Education

1. Analytic and diagnostic skills can be taught through low technology and fairly low cost means. Physical education preparation programs need to begin to investigate ways to incorporate this type of training into preparation programs to begin to develop more proficient analytic and diagnostic skills of physical educators.

2. The results of this study demonstrated induction of critical performance elements that were common. This may infer that it is possible to teach common critical elements that would generalize within sports and similar skills.

3. Analytic and diagnostic skills can be systematically taught. Skill analysis training needs to become a focus of physical education preparation programs. Major's activity classes need to incorporate analysis and diagnostic training as a part of the course.

4. Determining the most effective means for developing skill analysis ability for physical education majors needs to be further investigated. Due to an abundance of material in the curriculum the most effective means
for developing skill analysis training may be through self instructional packages. With the increase in video equipment and interactive videodiscs, these media could assist in developing analytic and diagnostic skills for undergraduate physical education teachers.  
5. Training for skill analysis development in physical education majors is usually the only training received by those who are also involved in coaching. The area of coaching needs to become a concern of physical education preparation programs.
APPENDIX A

Subject Contract for Participation
Contract for Participating in Diving Skill Analysis Training

This study will require you to memorize and recall a number of terms and pictures throughout both the graphics and video phases of the study. It is essential that you give 100% to learning and memorizing these key elements.

For the following four weeks you will be learning how to analyze and diagnose four different dives. Week one will be the forward dive straight, week 2 back dive pike, week 3 inward dive tuck, and week 4 forward dive half twist straight. You will attend two sessions per week, the first session will be the graphics phase, session two will be the video phase.

During the graphics phase you will be asked to go through a packet which will teach you the critical performance elements and common errors of the selected dives. You will be given 45 minutes to complete the packet. At the end of 45 minutes you will be given the graphics test. The graphics test includes three dives and asks you to list the six critical performance elements and discriminate between correct and incorrect diagrams. You must obtain 90% on this graphics test in order to go on. If you do not obtain 90% you will have to go through the graphics section again. When you obtain 90% you will then take the baseline video test (40 minutes).

The second phase requires you to view a 40 minute video. At any time during the video instruction you may review previous sections. At the completion of the video you will again take the video baseline test. It is essential that you concentrate and practice reviewing the critical performance elements, errors, and diagnosis for each dive.

The final session will include a video test to test generalization. This may be taken after your last session or scheduled for another time after the final session, but before the last Thursday of finals week.

I have read the above and understand the time commitment, expectations, and procedures that will be used for this study.

Date_________________ NAME_________________
APPENDIX B

Human Subject Consent for Participation
CONSENT FOR PARTICIPATION IN
SOCIAL AND BEHAVIORAL RESEARCH

I consent to participating in (or my child's participation in) research entitled:

explains the purpose of the study, the procedures to be followed, and the expected duration of my (my child's) participation. Possible benefits of the study have been described as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Further, I understand that I am (my child is) free to withdraw consent at any time and to discontinue participation in the study without prejudice to me (my child).

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ___________________________ Signed: __________________ (Participant)

Signed: ____________________________
(Principal Investigator or his/ her Authorized Representative)
Signed: ____________________________
(Person Authorized to Consent for Participant - If Required)

Witness: ________________

BS-027 (Rev. 3/87) — (To be used only in connection with social and behavioral research.)
APPENDIX C

List of Critical Performance Elements and Major Errors
Forward Dive Straight

1. Balanced approach and hurdle
   a. poor height in hurdle
   b. landing back on the end of the board
   c. lack arm circle during hurdle

2. Arms reach up, Upright body position
   a. short reach
   b. leaning forward

3. Dive up, Set T, Kick heels
   a. diving down to the water
   b. set front to back
   c. late or no heel kick

4. Flat layout position
   a. head down
   b. arms too far behind body in T position
   c. piked or arched body position

5. Close arms laterally
   a. arms circle underneath to close

6. Vertical stretch for entry
   a. short or long entry
   b. arched or bent body position
   c. reaching underneath
   d. ducking head
Back Dive Pike

1. Sit straight, Arm swing
   a. moving upper body
   b. poor arm circle

2. Arms reach up, Shoulders over toes
   a. short arm reach
   b. body weight falling back

3. Jump up, Straight legs, Lift toes
   a. lack of extension
   b. no leg lift
   c. bent legs

4. Touch toes short of vertical
   a. touch toes too high/ touch toes too low
   b. no toe touch

5. Upper body lays back, Arms wide
   a. legs drop / legs move with body
   b. narrow arms on come out

6. Vertical stretch for entry
   a. short or long entry
   b. arched or bent body position
   c. arms in front of forehead
   d. ducking head
Inward Dive Tuck

1. Sit straight, Arm swing
   a. moving upper body
   b. poor arm circle

2. Arms reach in front of forehead, Shoulders over board
   a. short reach / over reach
   b. body weight falling back

3. Narrow throw, Drive hips up
   a. arms throw wide
   b. late throwing upper half of body down
   c. drive hips too far back

4. Draw knees and arms into tuck position
   a. loose tuck
   b. arms fail touch legs

5. Kick out
   a. kick too high/ kick too low
   b. arms reach underneath

6. Vertical stretch for entry
   a. short or long entry
   b. arched or bent body position
   c. reaching underneath
   d. ducking head
Forward Dive 1/2 Twist Straight

1. Smooth and balanced approach and hurdle
   a. poor height in the hurdle
   b. landing back on the end of the board
   c. poor arm circle during hurdle

2. Arms reach up, Upright body position
   a. short reach
   b. leaning forward

3. Dive up, Set lead arm to water trail arm to T, Kick heels
   a. diving down to the water
   b. improper arm set
   c. late or no heel kick

4. Layout position 1/4 twist, Eyes focused on entry
   a. insufficient twist
   b. lose sight of water
   c. incorrect body position

5. Back dive entry, close arms laterally
   a. close arms too early
   b. arms close in front of or behind body

6. Vertical stretch for entry
   a. short or long entry
   b. arched or bent body position
   c. improper amount of twist
   d. ducking head
APPENDIX D

Graphics Package for Forward Dive Straight
Introduction

Skill analysis refers to the process by which a coach systematically observes their athletes skill performance response and on the basis of this observation identifies discrepancies between correct and incorrect performances. The information gathered from this observation serves as data for the coach to use to provide appropriate specific feedback to the learner (Hoffman, 1977). Skill analysis is one of the most important skills a coach can acquire.

It is relatively easy for a coach to observe a skill and determine if it was performed correctly or incorrectly. But it is much more difficult to determine which aspect of the skill needs to be corrected in order to improve the skill. Research has shown that teachers and coaches need to be trained to diagnose and prescribe remediation for performance errors of skill.

When viewing a 'form' sport such as diving it is easy to spot outcome results. For example the dive went too far over going into the water; the dive finished too far away from the board; or one may even note flat feet during some part of the dive. For a coach to give feedback for any one
of these errors that occurred may increase the beginning divers awareness of what happened during the dive; but would not really assist the diver in making corrections.

Outcome errors and minor form errors do not provide the beginning diver with enough feedback to correct their performance. Beginning divers need to know what major error(s) caused the type of outcome that occurred. A coach must be able to determine what parts of the dive were performed correctly or incorrectly and then determine which error should be attended to first in order to improve the execution of the dive.

The steps that will be used to develop analytical and diagnostic skills for this study will include the following steps:

1. Identification of critical performance elements for selected dives.
   
   Critical performance elements are selected movements important to a sequence of movements. When combined the critical performance elements form a successfully performed dive.

   
   Common errors of critical performance elements will be shown for beginning divers.
3. Diagnosis of the performance.

Diagnosis refers to the process of identifying the cause of the discrepancy between correct and incorrect execution and determining which error should be intervened upon first in order to improve the learners performance.

During this study you will participate in two training phases. The first phase will involve graphics and the second phase will involve videotape. Both phases will include the use of worksheets to help you learn the necessary information. A graphics test will be administered after the completion of the first phase. If you do not obtain 90% on this test you will be asked to review the graphics section again.

Videotape testing will be done prior to both phases, after the graphics, and after the videotape. Four basic dives will be used in the training: forward dive straight, back dive pike, inward dive tuck, and forward dive 1/2 twist straight. You will complete both the graphics and video phases for each dive before going on to the next dive.
Graphics Phase

You will have 45 minutes to go through this graphics package. Throughout the package you will be asked to perform a number of different practice exercises. Write your answers directly onto the answer sheets as you go through the package. When you have completed the package signal the proctor so you can take the graphics test.

To begin you will learn critical performance elements for the selected dives. Key phrases will be used to help you remember each of the performance elements. It is important for you to memorize the critical performance elements and gain a mental picture of each key step of the dive. This will give you a reference to compare other dives too. Being able to do this plays an important role in the process of analyzing and diagnosing dives.

The second part of the graphics will demonstrate examples of correct and incorrect execution of these critical performance elements. At the end of this section you will be able to discriminate between correct and incorrect graphics of the critical performance elements.
Outline of instructions for Graphics

A. Learn the six critical performance elements

1. View illustrations and labels
   a. Please read critical performance elements to yourself.
   b. Memorize labels

2. Worksheet no labels
   a. View worksheet and list the six critical performance elements on your answer sheet
   b. Check answers
   c. Repeat if you were not able to list all six critical performance elements correctly

3. No illustrations: Practice visualization of ideal illustrated performances
   a. Visualize six critical performance elements and list them in order of performance on the answer sheet
   b. Check answers
   c. Repeat if you were not able to list all six critical performance elements correctly

B. Discrimination of correct and incorrect critical element performances

1. Review illustrations and labels for critical performance element 1
   a. Please read information and view illustration for critical performance element 1

2. View illustrations and labels for common major errors for critical performance element 1
   a. Please read information and view illustrations for common errors

3. Review illustration and label for critical performance element 1
   a. Please read and view illustration
4. Worksheets with illustrations of correct and incorrect performances of critical element 1
   a. Visualize and write down the label for correct execution of critical performance element 1 on the answer sheet
   b. Discriminate if illustrations are correct or incorrect examples of critical performance element 1. On the answer sheet circle C for correct or I for incorrect
   c. If the illustration was incorrect, record the specific error that occurred on the right hand side of your answer sheet
   d. Turn the page and check your answers

C. Repeat the procedures from section B for the remaining five critical performance elements.

D. Written Review Quiz

1. On answer sheet, list the six critical performance elements for the dive

2. On the same answer sheet underneath the corresponding critical performance element list the specific errors that may occur when coaching beginning divers

3. Check answers
   a. Review any sections that you did not answer 100% correctly

E. When you have finished the graphics phase please signal the proctor that you are done.
   You will now take the Graphics Test
Critical Performance Elements for the Forward Dive Straight

1. Smooth and balanced approach and hurdle
2. Arms reach up, Upright body position
3. Dive up, Set T, Kick heels
4. Flat layout position
5. Close arms laterally
6. Vertical stretch for entry
View graphics and list the critical performance elements for the Forward Dive Straight

Critical Performance Elements

1.
2.
3.
4.
5.
6.

**Turn to next page to check your answers.**
Critical Performance Elements for the Forward Dive Straight

1. Smooth and balanced approach and hurdle
2. Arms reach up, Upright body position
3. Dive up, Set T, Kick heels
4. Flat layout position
5. Close arms laterally
6. Vertical stretch for entry

Did you get all six critical elements correct? Yes-GREAT! I turn to next page

No- review previous page and try again. Do not go on to the next page until you are able to list all critical performance elements correctly.
Visually picture critical performance elements in your mind and list them in order of performance.

1.

2.

3.

4.

5.

6.

**Turn to next page to check your answers.**
Critical Performance Elements for the Forward Dive Straight

1. Smooth and balanced approach and hurdle
2. Arms reach up, upright body position
3. Dive up, Set T, Kick heels
4. Flat layout position
5. Close arms laterally
6. Vertical stretch for entry

Were you able to list all of the critical performance elements?

Yes  EXCELLENT!! Go on to the next page.

No  Review previous sections and try again. Do not go on until you are able to list all critical performance elements for the forward dive straight.
Your ability to identify critical performance elements for specific dives is a crucial step in your ability to analyze and diagnose dives. The sequence of critical performance elements pictured and memorized by you will act as a standard of performance for you to compare other dives.

Noting whether a critical performance element was performed correctly or incorrectly is the first step in determining what needs to be corrected in a dive. As a coach it is essential that you are able to analyze, diagnose and prescribe appropriate feedback for athletes to improve their skill.

The next section will take a look at common errors which occur for beginning divers when performing the forward dive straight. For each critical performance element the correct execution is shown and then is followed by major errors which may occur during that step. At the end of each section there is a review which includes discriminating between correct and incorrect examples of the critical performance element.

At the end of this graphics section you will be asked to discriminate between correct and incorrect graphics of the six critical elements on a graphics test. You must obtain 90% to go onto the video phase.
1. BALANCED APPROACH AND HURDLE

The approach and hurdle should include at least three steps with an upward hurdle onto the end of the board. The three approach steps should be normal walking steps, body upright, average length and speed.

The hurdle should change divers forward momentum to vertical height. The length of the hurdle should be approximately 12-30 inches and at least 1 foot high.

The arms are carried down by the divers' sides during the approach and lift upward as the knee is lifted into the hurdle. As the diver steps down from the hurdle the arms circle down and around by hips as the diver's feet land on the end of the board.
Errors:
Major errors that occur during this step of the dive include:

A. Poor height in hurdle

Fault: The height of the hurdle does not rise above 1 foot from the board.

B. Landing back from the end of the board

Fault: Toes of the diver land further than 6 inches back from the end of the board.
C. Poor arm circle during hurdle

Fault: Arms are raised when lifting up into hurdle, but diver fails to circle them down by hips when stepping out of hurdle.

incorrect

correct
Forward Dive Straight

Critical Performance Element 1

Balanced approach and hurdle
Identify the first critical performance element for the forward dive straight.

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.
Identify the first critical performance element for the forward dive straight.

Balanced approach and hurdle

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.

- Poor height in hurdle
- Lack arm circle during hurdle
- Balanced approach and hurdle
2. ARMS REACH UP, UPRIGHT BODY POSITION

This step of the dive is very important to proper execution of the dive. Arms should continue to swing from the hurdle until they are straight up over head, in the 12 o'clock position.

The body position of the diver should be upright with head up and eyes focused on the other end of the pool.
Errors:
Major errors that occur during this step of the dive include:

A. Short reach

Fault: The diver's arms fail to reach up along ears and over head above the 1 o'clock position.

B. Leaning forward

Fault: The diver's shoulders should be in a vertical line in relation to their toes on the end of the board.
Forward Dive Straight

Critical Performance Element 2

Arms reach up, Upright body position
REVIEW

Identify the second critical performance element for the forward dive straight.

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.
REVIEW

Identify the second critical performance element for the forward dive straight.

Arms reach up, Upright body position

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.

leaning forward

Arms reach up, Upright body position

short reach
3. DIVE UP, SET T, KICK HEELS

Direction of the dive from the board should go upward.

As diver is completing extension through legs from the board, straight arms should set quickly and laterally to the T position. The arm action of the set includes moving arms from the 12 o'clock position, laterally in a plane with the body to shoulder height position.

Simultaneously the body should be tightened and heels lifted backwards and upward from the board.
Errors:
Major errors that occur at this step of the dive include:

A. Diving down to the water

Fault: The dive is low, it does not rise one body height above the board. The dive may also flip over too quickly.

B. Set front to back

Fault: The diver sets arms down in front of body and then to the sides, rather than pulling arms down laterally into the T position.
C. Late or no heel kick

Fault: The diver is piked coming off the board or in the air. Or the dive fails to rotate when the diver is in the straight position.

incorrect  correct
Forward Dive Straight

Critical Performance Element 3

Dive up, set T, kick heels
REVIEW

Identify the third critical performance element for the forward dive straight.

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.
REVIEW

Identify the third critical performance element for the forward dive straight.

Dive up, Set T, Kick heels

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.

Dive up, Set T, Kick heels

set front to back

late or no heel kick

diving down to the water
4. HOLD FLAT LAYOUT POSITION

During the flight of the dive the diver should momentarily hold a flat body layout position.

Head is in a neutral position and arms held at the T position in plane with the body.
Errors:
Major errors that occur during this step of the dive include:

A. Head down

Fault: The diver's head is not in the neutral position, this throws off the diver's straight body alignment.

B. Arms too far behind body in T position

Fault: Both of the diver's arms can be viewed during the flight of the dive, due to improper alignment of the T position. If the set is performed correctly you should only see one of the diver's arms when they are in the T position.
C. Piked or arched body position

Fault: The diver is piked during the flight of the dive. Or the diver is arched during the flight of the dive.
Forward Dive Straight

Critical Performance Element 4

Hold flat layout position
REVIEW

Identify the fourth critical performance element for the forward dive straight.

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.
Identify the fourth critical performance element for the forward dive straight.

**Flat layout position**

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.

- **head down**
  - [Image]

- **piked or arched body position**
  - [Image]

- **arms too far behind body in T position**
  - [Image]

- **Flat layout position**
  - [Image]
5. CLOSE ARMS LATERALLY

When the dive is just short of vertical, the diver should move arms laterally from the T position into position over head to begin line up.

During this movement the diver should maintain a flat body position.
Errors:
Major errors that occur during this step of the dive include:

A. Arms circle underneath to close

Fault: Rather than moving in arms laterally in line with the body, the diver circles arms in front of body and then up towards the head.
Forward Dive Straight
Critical Performance Element 5

Close Arms Laterally
REVIEW

Identify the fifth critical performance element for the forward dive straight.

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.
REVIEW

Identify the fifth critical performance element for the forward dive straight.

Close arms laterally

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.

Close arms laterally

arms circle underneath to close
6. VERTICAL STRETCH FOR ENTRY

The diver should enter the water vertically.

The head should be in line with the arms with eyes focused on the water.

The diver's body position should be flat and extended from finger tips to toes.
Errors:
Major errors that occur during this step of the dive include:

A. Short or long entry

Fault: The diver enters the water below 15 degrees of vertical (short). The diver enters the water past 15 degrees of vertical (long).

B. Arched or bent body position

Fault: The diver's body is not in a streamline position entering the water. The diver may be piked or may be arched during the entry.
C. Reaching underneath

Fault: The diver does not line arms up over ears, rather they reach to the water in front of their body.

D. Ducking Head

Fault: As the diver is lining up for the water, the diver tucks chin toward their chest making them lose sight of the water.
Forward Dive Straight
Critical Performance Element 6

Vertical stretch for entry
Identify the sixth critical performance element for the forward dive straight.

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.
Identify the sixth critical performance element for the forward dive straight.

**Vertical stretch for entry**

Determine if the diagrams below show correct or incorrect execution of the critical performance element mentioned above. If the diagram is incorrect list the error which occurred.

- Reaching underneath
- Short or long entry
- Vertical stretch for entry
- Arched or bent body position
To review list the critical performance elements of the forward dive straight. Under each critical element list the major errors which may occur during each step.

1. Critical Performance Element Errors

2.

3.

4.

5.

6.
Forward Dive Straight

1. Balanced approach and hurdle
   a. poor height in hurdle
   b. landing back on the end of the board
   c. lack arm circle during hurdle

2. Arms reach up, Upright body position
   a. short reach
   b. leaning forward

3. Dive up, Set T, Kick heels
   a. diving down to the water
   b. set front to back
   c. late or no heel kick

4. Flat layout position
   a. head down
   b. arms too far behind body in T position
   c. piked or arched body position

5. Close arms laterally
   a. arms circle underneath to close

6. Vertical stretch for entry
   a. short or long entry
   b. arched or bent body position
   c. reaching underneath
   d. ducking head
Instructions for Graphics Test

A. View illustrations for Graphics Test 1

1. On the answer sheet list the six critical performance elements in order of occurrence.

2. For each critical performance element view illustration and determine if the element is performed correctly or incorrectly.
   a. On the answer sheet circle the word for the appropriate answer (correct/incorrect).

3. If you marked incorrect, record the specific error that occurred on the right hand side of the answer sheet.

4. At the bottom of the answer sheet answer the question: What specific error would you correct first in this dive?

B. Repeat the above procedures for the remaining two graphics test.

C. When you have finished the graphics test signal the proctor.

1. Your test will be graded. If you received 90% you will go on to take the video test.
2. If you obtained lower than 90% on the graphics you must review graphics package and retake the graphics test. You can not go on until you obtain 90% on the graphics test.
DIVE Forward Dive Straight
Dive Forward Dive Straight
List the Critical Performance 
Elements

<table>
<thead>
<tr>
<th>Subject number</th>
<th>CPE1</th>
<th>CPE2</th>
<th>CPE3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CPE4 1) C or I
    2) C or I
    3) C or I

CPE5 1) C or I
    2) C or I
    3) C or I

CPE6 1) C or I
    2) C or I
    3) C or I

What specific error would you correct first for this dive?

Subject 1

Subject 2

Subject 3
APPENDIX E

Score Sheet for Performance Assessment Test
You are about to observe a video of a number of different students performing various dives. The dives which you will observe will be forward dive straight, back dive pike, inward dive tuck, and forward dive 1/2 twist straight. For each group of dives (forward, back, etc) you will use one three page answer packet for each group of dives that you observe. Take time now to fill in the top page of all four packets of answer sheets: record your name, date, session number, and dive.

Each person you observe will be referred to as a subject and will be given a subject number. You will observe each subject perform the same dive three times (dive 1, dive 2, and dive 3) at normal speed.

After viewing the first dive for each subject list in sequential order what you consider to be the six most important key points or critical performance elements (CPE's) for a novice diver. A critical performance element is a selected movement important to a sequence of movements. When combined, critical performance elements form a successfully performed sports skill. There will be 45 seconds after the first viewing of each subjects dive. Record your answers down the left hand side of the pages 1 and 2 in the appropriate place on your answer sheet (CPE 1).
After the second viewing of the same dive (dive 2), you will have 30 seconds to respond to error discrimination. During this time record if the critical performance elements were performed correctly or incorrectly. Circle C if correct or I if they were performed incorrectly. Be sure to record your answer next to the corresponding number of the subject you are observing. If you have circled incorrect list the major specific error(s) which have occurred. Record your answer to the right of the incorrect marking for that CPE.

After the last viewing of the dive, you will respond to the question: "What specific error would you correct first in this dive?" Record your answer on the last page (page 3) in the area corresponding with the subject number you just observed. You will have 15 seconds to record your answer. Remember to record your answers with the corresponding subject number that you just observed.
<table>
<thead>
<tr>
<th>Subject number</th>
<th>Critical Performance Elements</th>
<th>Correct or Incorrect</th>
<th>List specific Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE1</td>
<td></td>
<td>1) C or I</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) C or I</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) C or I</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) C or I</td>
<td></td>
</tr>
<tr>
<td>CPE2</td>
<td></td>
<td>1) C or I</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>2) C or I</td>
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<tr>
<td></td>
<td></td>
<td>3) C or I</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>4) C or I</td>
<td></td>
</tr>
<tr>
<td>CPE3</td>
<td></td>
<td>1) C or I</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>2) C or I</td>
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<td></td>
<td></td>
<td>3) C or I</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) C or I</td>
<td></td>
</tr>
</tbody>
</table>
CPE4 1) C or I 2) C or I 3) C or I 4) C or I

CPE5 1) C or I 2) C or I 3) C or I 4) C or I

CPE6 1) C or I 2) C or I 3) C or I 4) C or I

What specific error would you correct first for this dive?

Subject 1 _________________________________________________________

Subject 2 _________________________________________________________

Subject 3 _________________________________________________________

Subject 4 _________________________________________________________
APPENDIX F

Line Graphs of Number of Critical Performance Elements Visually Identified
Baseline Intervention /Probe graphics video

Generalization trained/untrained

<table>
<thead>
<tr>
<th>Session</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Dive</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Back Dive</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Inward Dive</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Number of critical performance elements visually identified by subject one.
Number of critical performance elements visually identified by subject two.
Number of critical performance elements visually identified by subject three.
Baseline Intervention /Probe graphics video

Generalization trained/untrained

<table>
<thead>
<tr>
<th></th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
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<th>0</th>
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<tbody>
<tr>
<td>Forward Dive</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Back Dive</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>Inward Dive</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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</table>

Number of critical performance elements visually identified

Forward Dive 1/2 Twist
X Visual Identification

Number of critical performance elements visually identified by subject four.
Baseline Intervention/Probe graphics video
Generalization trained/untrained

Forward Dive

Back Dive

Inward Dive

Number of Critical Performance Elements Visually Identified

Session

Forward Dive 1/2 Twist
X Visual Identification

Number of critical performance elements visually identified by subject five.
<table>
<thead>
<tr>
<th>Number of Critical Performance Elements Visually Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Intervention / Probe graphics video Generalization trained/untrained</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>Forward Dive</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

Forward Dive 1/2 Twist
X Visual Identification

Number of critical performance elements visually identified by subject six.
Baseline Intervention/Probe graphics video

Generalization trained/untrained

Forward Dive

Back Dive

Inward Dive

Forward Dive 1/2 Twist

X Visual Identification

Number of critical performance elements visually identified by subject seven.
Baseline Intervention
/Probe graphics video

Generalization
trained/untrained

Number of critical performance elements visually identified by subject eight.
Baseline Intervention /Probe graphics video

Generalization trained/untrained

Number of Critical Performance Elements Visually Identified

<table>
<thead>
<tr>
<th>Session</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>8</th>
<th>9</th>
<th>10</th>
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</thead>
<tbody>
<tr>
<td>Forward Dive</td>
<td>6</td>
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<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Inward Dive</td>
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<td>1</td>
<td>0</td>
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</tbody>
</table>

Forward Dive 1/2 Twist

X Visual Identification

Number of critical performance elements visually identified by subject nine.
Baseline Intervention /Probe graphics video

Generalization trained/untrained

Number of critical performance elements visually identified by subject ten.
Number of critical performance elements visually identified by subject eleven.
Baseline Intervention
/Probe graphics video

Generalization
trained/untrained

Number of Critical Performance Elements Visually Identified

Forward Dive

Back Dive

Inward Dive

Session

1 2 3 4 5 6 7 8 9 10

Forward Dive 1/2 Twist

X Visual Identification

Number of critical performance elements visually identified by subject twelve.
Number of critical performance elements visually identified by subject thirteen.
Number of critical performance elements visually identified by subject fourteen.
APPENDIX G

Bar Graphs of Major Errors Identified Correctly
Percentage of Major Errors Identified Correctly

<table>
<thead>
<tr>
<th>Twist Dive</th>
<th>Inward Dive</th>
<th>Back Dive</th>
<th>Forward Dive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session</td>
<td>Percent of major errors identified correctly by subject one.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Percentage of Major Errors Identified Correctly

Session 1 2 3 4 5 6 7 8 9 10

Twist Dive
Inward Dive
Back Dive
Forward Dive
Percentage of Major Errors Identified Correctly

Session

- Twist Dive
- Inward Dive
- Back Dive
- Forward Dive

[Graph showing the percentage of errors identified correctly for different dives.]
Percentage of Major Errors Identified Correctly:

- Twist Dive
- Inward Dive
- Back Dive
- Forward Dive

Sessions 1 to 7.
Percentage of Major Errors Identified Correctly

Session

Twist Dive

Inward Dive

Back Dive

Forward Dive

Percentage Correctly by Subject Type.
Percentage of Major Errors Identified Correctly by Subject Size.
<table>
<thead>
<tr>
<th>Sessions</th>
<th>Twist Dive</th>
<th>Inward Dive</th>
<th>Back Dive</th>
<th>Forward Dive</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<td>7</td>
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</tr>
</tbody>
</table>

Percentage of Major Errors Identified Correctly.
Percentage of Major Errors Identified Correctly

Twist Dive  Inward Dive  Back Dive  Forward Dive

Session 1  Session 2  Session 3  Session 4  Session 5  Session 6  Session 7  Session 8

Percentage of major errors identified correctly by subject eight.
Percentage of Major Errors Identified Correctly

Percent of major errors identified correctly by subject nine.
Percentage of Major Errors Identified Correctly by Subject Ten.
Correctly by subject eleven.

Percentage of major errors identified correctly.
Percentage of Major Errors Identified Correctly

Twist Dive  Inward Dive  Back Dive  Forward Dive

Percent of major errors identified correctly by subject twelve.
Percentage of Major Errors Identified Correctly:

[Graph showing percentage of errors identified correctly over sessions for different types of dives: Diving, Inward Dive, Back Dive, Forward Dive.]
Percent of major errors identified correctly by subject fourteen.
LIST OF REFERENCES


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