THE EFFECTS OF INDIVIDUALIZED VIDEOTAPE INSTRUCTION
ON THE ABILITY OF UNDERGRADUATE PHYSICAL
EDUCATION MAJORS TO ANALYZE
SELECT SPORT SKILLS

DISSERTATION

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

By

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* * * * *

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INTRODUCTION

The ability to accurately observe learner responses as a precursor to corrective feedback stands as one of the most important yet least investigated operations in motor skill instruction. Neglect of the topic by researchers has retarded the design and implementation of training programs for teachers and coaches who, from the lack of it, have been forced to train themselves through the random contingencies of day-to-day teaching. (Imwold and Hoffman, 1983, p. 149)

Without question one of the most important functions in teaching physical education is the ability to observe and analyze sport performance (Williams, Dambach & Schwendener 1938; Huelster, 1939). Successful learning in physical education or athletics depends largely on a teacher or coach's ability to accurately analyze students or athletes performing sport skills and provide appropriate kinds of feedback to move the learner closer to the desired movement outcome. With regard to skill analysis, Hoffman (1977b) states, "In the gymnasium, skill analysis refers to a process in which the teacher or coach systematically observes the responses of his students and, on the basis of his observation, identifies discrepancies between actual and desired response characteristics" (p. 1). A crucial link between
naked eye observation and analysis, and the desired learner response characteristics is feedback.

Feedback refers to information generated about a response that is used to modify the next response (Siedentop, 1976). Feedback is a necessary condition for learning (Siedentop, 1976). The fact that the integrity of the feedback prescribed is dependent upon the teacher's ability to analyze what he/she sees is plainly evident, yet very little is known about this important aspect of teaching let alone how to prepare teachers to acquire the relevant analytical skills. According to Kretchmar, Sherman and Mooney (1948)

Clearly, knowing how to observe is important, and clearly, too, the ability to observe is sufficiently independent of other performance abilities to require special treatment in its own right, if physical education teachers are to be well prepared. (p. 242)

Over the past decade physical education teacher preparation programs have benefited from research efforts in classroom management and teacher effectiveness. Natural science methodologies have been employed to define, measure, and analyze teacher and student behavior giving those that prepare future teachers the clearest picture yet of what teacher effectiveness really means. Unfortunately, analysis of sport skills as a pedagogical function within the teaching setting remains largely ignored.
Traditionally the responsibility of teaching sport skill analysis rests with those who teach kinesiology and biomechanics. Both sciences provide important knowledge for the preparation of physical education teachers and coaches, but have done little to help future teachers and coaches become effective analyzers of sport skills in typical teaching and coaching settings. Hoffman (1977c) maintains that kinesiology, as it is taught today, proves to be an excellent introductory course for students desiring careers in kinesiology, but fails as a course that trains prospective teachers how to analyze the responses of their students. Locke (1972) refers to kinesiology, as it is structured for undergraduates, as, "a dry well as an influence on teacher behavior" (p. 382).

Hoffman (1977c) and Hay (1973) argue that more sophisticated equipment and advanced technology are leading factors in moving kinesiology in a clinical-quantitative direction while teachers need to be trained in qualitative methods in observing and assessing human movement as it occurs in real teaching settings. Laboratory analysis is, at best, remotely related to what Gangstead and Beveridge (1984) refer to as, "the problematic observational task which awaits the teacher" (p. 60). These researchers point to the complex visual display of body parts, moving through space, within a fleeting moment, that compete for the teacher's visual
attention. Add to this a backdrop of distracting, irrelevant visual and auditory stimuli and the disquieting fact that there is no definitive agreement on what "critical features" (Barrett, 1979) or performance points make up the desired response characteristics of any skill. Clearly the time is at hand for those responsible for kinesiology and pedagogy to bridge the gap between knowledge and practice.

A small number of studies have begun to address the problem. Error identification and detection in the performance of motor skills have received attention (Giradin & Hanson, 1967; Vanderbeck, 1979). Models for the analysis of sport skills have been presented (Gentile, 1972; Barrett, 1979; Stadulus, 1972). Naked eye observation and analysis of sport skills research has been conducted (Moody, 1967; Sembiante & Hoffman, 1975; Biscan & Hoffman, 1976; Gangstead, 1982; Imwold & Hoffman, 1983). Such studies represent the first thrust in an important research field for teacher education in physical education.

Hoffman, through his writing and research, has been the leader in the study of applied sport skill analysis. His paper titled "Toward a Pedagogical Kinesiology" published in 1977 describes a way to bridge the gap between knowledge and practice and provides the tenets of a pedagogical kinesiology, listed below, that guide this research project.

1. Movement responses or critical elements (performance points) for any given skill can
be categorized into systematic taxonomies (Hoffman, 1977c).

2. Teachers must be trained to discriminate correct and incorrect response characteristics for a given sport skill through observation training programs (Hoffman, 1977c).

3. Sport skills must be evaluated on a qualitative basis with specific parameters for each response (Hoffman, 1977c).

4. Knowledge of mechanical principles will not help teachers distinguish the difference between correct and incorrect movement responses (Hoffman, 1977c).

5. Skill analysis training is best accomplished in simulated or field-based settings where real performance efforts, not contrived, are studied (Hoffman, 1977c).

6. The terminology of pedagogical kinesiology is based on brief summary labels and sharp picture words that are specific to the skills being analyzed (Hoffman, 1977c).

7. Instrumentation for training and evaluation of a student's ability to analyze sport skills is an important key in the development of pedagogical kinesiology (Hoffman, 1977c).

Statement of the Problem

The purpose of this study was to determine whether undergraduate physical education majors could improve their ability to analyze middle school students performing select sport skills as a result of individualized videotape instruction. Of particular interest was the effect this instructional strategy would have on a subject's ability to
verbatim identify the critical elements of a sport skill
(see examples of critical elements for this study in Appendix
B, p. 137) and visually discriminate those elements as
correct, incorrect or missing when viewing selected middle
school students. Listed below are eight specific research
questions this study addressed:

1. How do subjects analyze sport skills verbally,
under baseline conditions, prior to interven-
tion?

2. How do subjects analyze sport skills visually,
under baseline conditions, prior to inter-
vention training?

3. Can subjects consistently recall five
different critical elements for each of four
different sport skills after viewing interven-
tion training tapes?

4. Can subjects visually discriminate the
difference between correct and incorrect
critical elements after intervention training?

5. What is the relationship between the ability
to verbally identify the critical elements of
a sport skill and the ability to visually
discriminate critical elements as correct or
incorrect?

6. Can sport skill analysis proficiency acquired
through individualized videotape instruction
be successfully generalized to students prac-
ticing sport skills in real school settings?

7. Which critical elements, skill, or skills do
subjects find most difficult to analyze?

8. Are subjects, as consumers of individualized
videotape instruction in sport skill analysis,
satisfied with the procedures and results?
Limitations of the Study

This study was limited by the following factors:

1. This study was limited to OSU undergraduate physical education majors.

2. This study was limited to four select sport skills:
   a) standing long jump
   b) overarm throw
   c) batting from a tee
   d) cartwheel

3. This study was limited to five individualized videotape testing and instruction sessions, and one generalization testing session conducted within a two-week period.

4. This study was limited to the inclusion of middle school students (grades, 6, 7, 8) from two Columbus City Schools as videotaped and live subjects for analysis.

Assumptions of the Study

The following are assumed to be true and pertinent to the study:

1. The ability to analyze sport skills is measurable.
2. The critical elements that comprise a sport skill can be defined, observed, and measured.

3. The middle school students who participated in the videotaping and live performance of sport skills constituted a representative sample of middle school students.

4. The critical elements observed and measured in this study were representative of each student's actual response characteristics.

**Definition of Terms**

For the purpose of this study, the following definitions have been included.

**Analytic ability** - The ability to correctly identify the critical elements of a sport skill and indicate whether each element was correct, incorrect or missing.

**Baseline** - The measure of subject behavior prior to the introduction of the independent variable or experimental treatment.

**Closed skill** - A closed skill is a skill representing predictable movement requirements within a fixed environment (Poulton, 1957).

**Critical element** - One specific movement in a series of movements combined in a particular time-space sequence to
form a successfully performed sport skill (see Appendix B).

**Discrimination** - "The restriction of responding to certain stimulus situations and not others" (Sulzer-Azaroff, 1977, p. 515).

**Generalization** - The transfer of learning from one setting to another.

**Intervention** - Systematic introduction of the independent variables (instructional videotapes).

**Multiple baseline research design** -

A within-subject experimental design that attempts to replicate the effects of a procedure (treatment or intervention) across (1) different subjects, (2) different settings, or (3) different classes of behavior. The intervention is introduced independently to each subject (or setting or class of behavior) in succession (Sulzer-Azaroff, 1977, p. 519).

**Performance** - "A performance is a motor activity that is to be done or that has been done" (Wickstrom, 1977, p. 5).

**Probe** - Periodic measurement of responses during baseline and intervention.

**Skill analysis** - A process in which a teacher or coach systematically observes motor responses of his students, and
on the basis of his observation, identifies discrepancies between actual and desired response characteristics (Hofman, 1977c).

Sport skills - "Sport skills are fundamental skills that have been adapted to the special requirements of a particular sport or game" (Wickstrom, 1977, p. 12).

Visual discrimination - the ability to visually distinguish between critical elements performed correct and incorrect.

Verbal identification - the ability to correctly record in writing any one or all of the critical elements of a sport skill.

Summary

Sport skill analysis has long been recognized as an important function in teaching physical education and coaching athletes, but very little is known about naked eye analysis of sport skill performance or how to effectively equip future teachers and coaches with relevant analytical skills. The assumption has traditionally been made that courses in kinesiology and biomechanics adequately prepare teachers and coaches to be effective skill analyzers, but no empirical evidence exists to support this claim. The trend among those who teach kinesiology and biomechanics is to advance their work and research in a clinical-quantitative direction while teachers and coaches need to be trained in qualitative methods in observing and analyzing human movement as it
occurs in real teaching and coaching settings.

Hoffman, through his writing and research, has been the leader in the study of applied sport skill analysis. His paper titled, "Toward a Pedagogical Kinesiology", published in 1977 describes the tenets of a pedagogical kinesiology that facilitate qualitative sport skill analysis.

The purpose of this research was to determine whether undergraduate physical education majors could improve their ability to analyze middle school students performing select sport skills as a result of individualized videotape instruction based on the tenets of pedagogical kinesiology.
CHAPTER II

REVIEW OF RELATED LITERATURE

Those who are inexperienced in the field often assume that he who knows how to play a game well will himself be a good observer and analyst of the play of others. But such is frequently not the case. On the other hand, there are men who are not able to play a game themselves who make excellent observers and analysts. (Kretchmar, Sherman and Mooney, 1948, p. 242).

This "paradox of analysis" represents one of the most seriously unanswered questions facing those who prepare physical education teachers and coaches today. Some time ago Kretchmar, Sherman and Mooney (1948) called for identification of the most productive visual habits for observing the intricately moving configuration of the human body as well as specifying the kind of training program that would best achieve this as a means of preparing physical education teachers. What follows is a review of research conducted in sport skill analysis as well as a review of proposed models for systematic observation and analysis of sport skills. The chapter closes with a brief overview of observation discrimination training.
The Role of Mental Imagery in Sport Skill Analysis

The function of mental imagery in sport skill analysis remains largely unexplored, however, according to Welford (1972), "The now commonly accepted view is that some kind of representation of the goal is set up in the analyzer and that the data about the state of affairs after each action are compared with this" (p. 302). In agreement with this premise, Whiting (1972) identifies a three step process teachers use to help learners acquire skills. First, the teacher must provide the learner with an appropriate model of the skill to be learned. Second, the teacher must possess in his or her mind a visual model of the skill against which skill attempts by the learner can be compared. Third, the teacher must be able to provide the learner with adequate feedback based on the difference between the learner's attempts and the model held in the teacher's mind. In this regard Biscan and Hoffman (1976) suggest, "...the extent to which teachers can formulate and reproject a vivid image of the criterion response and accurately compare that image with the response under immediate observation, to a large degree, may determine proficiency in analyzing skill" (p.161).

Mental images have been described by Pivio (1971) as perceptual analogs, possessing a one-to-one
correspondence with all real world objects. However, many
cognitive psychologists would disagree by defining mental
images as internal representations of objects and events
actively constructed by the brain thus representing more than
static residuals of perception. Tulving (1974) proposes that
mental images can be pulled from long term memory and up-
dated in light of newly acquired information. According to
Helgard, Atkinson, and Atkinson (1975) individuals differ in
their ability to image. Hunter (1977), Pressley and Levin
(1980) present empirical evidence that relates imagery to
recall. This work is supported by Frey and Adesman (1976)
that report chess skill is correlated with recall ability
for chess configurations. High and medium skilled players
demonstrated better recall than novice players. Vividness
of mental images have also been studied. Marks (1973) indi-
cates that subjects who reported vivid visual images were
more accurate in their ability to recall than subjects who
reported weaker images.

Moody (1967) studied the mental imagery differences
among four groups of university women including 14 physical
education faculty, 18 senior physical education majors, 19
freshman physical education majors, and 26 freshman non-
majors. Each group represented differences in experience,
interests, and motor skill ability. The four groups were
given three different mental imagery tests. Test One
required subjects to observe a short film and recognize
previously viewed geometric images from among four similar shaped images. Test Two required the subject to view a movie of a motor act and a few seconds later select the same motor act from among four similar acts. Test Three required subjects to view a movie of a motor act and then answer a series of five questions related to details of the act. The results of the study showed that groups representing different levels of experience, interest, and motor skill ability, did not significantly differ on their ability to recognize previously presented geometric shapes or motor acts. However, subjects having high levels of experience, interest, and ability in motor performance were significantly more capable of remembering details of motor demonstrations. Moody noted that in Test One, a majority of subjects assisted their memory by attaching their own verbal labels to parts of the originally viewed geometric shapes. Subjects also used verbal labels to help remember motor acts in Test Two and Three when they were familiar with the skill being presented.

Sheehan and Neisser (1969) indicate that the role of images in the recall process is unclear, however, it appears that three different functions are possible as follows: (1) the subject may use an image as the only source of information reading from it as necessary; (2) the image is one of several sources used by the subject; (3) the image is available, but the subject uses other kinds of information.
Skill Level and Analytic Proficiency

Singer (1980) states, "A skill...is specific to given tasks and is attained with experience. Because it is task-oriented, skill usually refers to a highly developed specific sequence of responses" (p. 31). Several studies have investigated the relationship between skill level and analytic ability.

Girardin and Hanson (1967) investigated the relationship between the ability to perform a sport skill and the ability to diagnose performance errors. Thirty-two physical education majors were given a knowledge test of mechanical execution of eleven different tumbling skills. Each subject was then filmed performing the eleven skills and evaluated by experts. Subjects then diagnosed errors in the same eleven skills performed on film by a demonstrator. A significant correlation \( r = .49 \) was found between performance ability and diagnostic ability. A significant correlation \( r = .51 \) was also found between knowledge and diagnostic ability. No significant relationship between knowledge and performance ability was established. It should be noted that the relationships, while significant statistically, were only of moderate strength.

Osborne and Gordon (1972) tested 90 male college students in beginning tennis classes on their ability to rate six specific body movements found in the eastern forehand
tennis stroke as correct or incorrect. The subjects were
grouped according to ability to perform the eastern forehand
tennis stroke in high, medium, and low skill levels. Each
subject then observed a slow motion color film of an actor
performing 16 eastern forehand tennis strokes. By design
the performer executed different elements of each stroke
correct or incorrect. Half of the subjects viewed the film
and rated each component of the stroke as correct or incorrect
while the remaining group of subjects received feedback after
evaluating each component as correct or incorrect. The re-
sults showed that raters were more successful in identifying
correctly performed elements of movements than identifying
incorrectly performed movements of a sport skill. Gordon
(1970) refers to this finding as the Differential Accuracy
Phenomenon. The researcher found no significant differences
between skill level and overall accuracy of rating movements,
or feedback and overall accuracy of rating movements.

Armstrong (1976) examined the effect of kinesthetic per-
formance experience on analytic ability. Thirty-three sub-
jects composed of physical education faculty and under-
graduate physical education majors volunteered to participate
in this study. Subjects were randomly assigned to one of
three treatment groups. In all groups, subjects viewed a
novel motor skill. A novel motor skill was utilized to con-
trol for experience among subjects. The first treatment
group practiced 10 repetitions of the skill and 20
repetitions of a similar skill. Treatment group two practiced 30 repetitions of the novel motor skill. Treatment group three practiced 30 repetitions of a skill similar to the standard skill. All subjects then participated in a training program to discriminate between four separate parts of the novel motor skill. All subjects then viewed filmed performances of the skill and were required to identify the four component parts. Analysis of the data indicated that kinesthetic experience did not influence the analytic ability of subjects to identify the component parts of the novel motor skill.

Teaching Experience, Coaching Experience and Analytic Proficiency

Locke (1972) identifies the fact that teacher training programs in physical education operate on the assumption that undergraduate courses in biomechanics and kinesiology provide students with a generic ability to analyze skills. He points out that, in reality, this is not the case. In fact, no empirical evidence exists to support such an assumption. Instead, Locke (1972) suggests that skilled analyzers owe their analytic ability not to courses in biomechanics, or kinesiology, but to the practice of sport skills, previous performance of sport skills, and the study of critical elements that comprise sport skills. The following studies support Locke's position.
Hoffman and Sembiante (1975) conducted research to determine the differences in analytic ability between sport coaches with coaching experience but no formal sport training and teachers with formal sport training, but no coaching experience. The effect of mental imagery on analytic ability was also tested. Subjects for this study included town recreation baseball and softball coaches (n = 15) with an average of 5 years coaching experience, but no formal training in sports or sport skill analysis. A second group of subjects was composed of physical education teachers (n = 16) with either one course in biomechanics or kinesiology, but no softball/baseball coaching experience. The third group was a control (n = 14) including subjects with no training in sports, sport skill analysis, or experience in athletics. All subjects were male and prior to the start of the study all subjects were tested on the Betts QMI Vividness of Imagery Scale and the Gordon Test of Visual Imagery Control. Subjects were then tested for analytic proficiency by first viewing a batting prototype (model performance) four times and then had to determine whether ten additional filmed batting responses differed or were the same as the original prototype. The same procedure was repeated with a novel skill prototype. Results showed that the coaches scored significantly higher than teachers or the control group on the analysis of batting test, but no significant difference was indicated between the three groups on the novel skill
analysis test. Of further interest was the finding of a significant relationship between analysis scores and subject's ability to control a visual image as determined on the Gordon Test. With regard to this finding, Hoffman and Sembiante (1975) note, "This strongly suggests that the ability of the analyst to formulate and control a vivid visual image of the criterion performance may be a crucial determinant of proficiency in this type of analytic task" (p. 7). The most important finding of this study, however, appears to be the fact that experience with a sport skill proved to be a more important factor in determining analytical ability than formal training in physical education.

Biscaii and Hoffman (1976) conducted research to investigate whether physical education teachers and undergraduate physical education students possess special proficiency in skill analysis and to determine if analytic proficiency could be successfully applied beyond familiar skills. Three groups of subjects were utilized including experienced physical education teachers (n = 21), undergraduate students in a biomechanics course (n = 21), and a group of junior high school classroom teacher (n = 21). Subjects viewed two filmed performances of the same prototype cartwheel which served as a model against which ten different filmed cartwheel performances had to be compared. Subjects then repeated the procedure for the prototype of a novel gross motor skill.
Results showed that physical education teachers and undergraduate students were superior to classroom teachers when making a comparative analysis with a skill for which they were familiar. However, no significant difference among the three groups was found for the novel skill analysis. Therefore, generic analytic ability was disproved in this study.

**Error Identification and Analytic Proficiency**

Analytic proficiency has also been studied by focusing research efforts on error identification. Hoffman and Armstrong (1975) suggest that analytic proficiency can best be developed when training programs include visual experience with common performance errors as well as skilled performances rather than skilled performances alone.

Hoffman and Armstrong (1975) researched the effects of four pretraining conditions on performance error identification. The researchers produced eight millimeter test films of authentic standing long jump performances by children in grades K-9. The performances were evaluated by two independent judges who scored each performance on eight criteria. Eighty-six first through fourth year physical education majors served as subjects for this study. Subjects were tested on two different mental imagery tests and then randomly assigned to one of four pretraining conditions. In
the first condition, titled Correct, subjects studied the eight criteria, matched each performance phase of the jump with the correct criteria, and observed correct jumping performances. In the second condition, titled Verbal, subjects were only given verbal descriptions of the performance criteria. No visual examples of jumping performance were provided. In the third condition, titled Correct-error, subjects studied the performance criteria, observed correct jumping performances, and practiced identifying errors in jumping performances. In the fourth condition, subjects served as a Control group and observed an irrelevant film on throwing. An error identification test was administered immediately following pretraining. Subjects observed 12 jumping films and answered four questions, with a yes/no response, for each film. Subjects had to determine if the observed performances conformed to the established eight item criteria. Mean scores for the initial error identification test were determined as follows: Correct condition, $\bar{x} = 34.81$; Correct-verbal, $\bar{x} = 35.80$; Correct-error, $\bar{x} = 36.06$; Control, $\bar{x} = 32.64$. ANOVA showed that the resulting differences were significant $F (3,79) = 6.01$, $p < .01$. The means for Correct-verbal and Correct-error were significantly higher than the Correct only condition. Three weeks later, a retention test was conducted. Results indicated that scores remained stable and did not change significantly over the interval.
Armstrong and Hoffman (1979) conducted research to determine the error detection differences between experienced and inexperienced tennis teachers. Subjects were required to identify performance errors in the tennis forehand shown on film. Error detection proficiency between the two groups was further tested by providing subjects with preresponse information concerning the performer's level of competence in skill (PCI), and postresponse information about the outcome produced by the response (POI). The subjects for this study included experienced tennis teachers (n = 40) and inexperienced teachers (n = 40) composed of undergraduate physical education majors. Subjects within each group were randomly assigned to one of four conditions: (1) performer competence information present/performance outcome information present (PCIP-POIP), (2) performer information present/performance outcome information absent (PCIP-POIA), (3) performer competence information absent/performance outcome information present (PCIA-POIP), (4) performer competence information absent/performance outcome information absent (PCIA-POIA). Subjects observed a test film of 15 different examples of tennis performers executing the forehand stroke modeling predetermined error combinations. Subject scores were analyzed using a three-way ANOVA which showed a significant main effect for experience. No significant main effects were observed for PCI or POI. Of further interest was the finding that experienced teachers who did not receive either
PCI or POI scored slightly higher (nonsignificant) error detection scores than teachers that were supplied either one, or both kinds of information. An analysis of the types of errors committed by both groups showed two commonalities. First, subjects would sometimes fail to identify performance of errors when in fact they were demonstrated in the film. These were referred to as "misses". Second, subjects would sometimes indicate errors when in actuality there were no errors. These were referred to as "false alarms". Inexperienced teachers demonstrated a significantly greater number of "false alarms" than experienced teachers while no difference was demonstrated between the two groups in the number of "misses" recorded. After analyzing the false alarms and misses, Armstrong and Hoffman noted that the better error detection scores produced by the experienced subjects were not due to superior error detection ability, but were in fact the result of inexperienced teachers making more false alarms. The researchers concluded that the experienced tennis teachers were only marginally better error detectors than inexperienced tennis teachers and that experienced teachers made fewer false alarms than inexperienced teachers.
Models For Observation And Analysis of Sport Skills

Three dissertation projects have been developed which featured identification of errors in sport skills by utilizing instructional films. Homewood (1955) developed a basketball training film for beginning female basketball players which featured basic performance errors and provided proper coaching points. Mabry (1965) developed a film to help golf teachers recognize some of the most common errors exhibited by beginning women golfers. Higgins (1970) developed loop films which depicted model skill performances as well as common errors associated with volleyball. In each project a literature review was conducted and experts were surveyed to identify the most common performance errors. Identification of performance errors in sport skills is not an easy task as Higgins (1970) notes:

There was no definite pattern of approaching the description of errors in the books reviewed. Therefore, it was deemed necessary to assume that any deviation from the points described as correct execution of skills be considered as an error in performance of the skill. (p. 7)

Expert performers were used in these films to demonstrate the performance errors. Hoffman (1977c) questions the ability of skilled performers to accurately simulate the performance errors of beginners and calls for the use of actual performance errors in skill analysis training.
Wallis (1963) advocates the use of realistic presentations (based on real material) throughout a training program. Unfortunately, none of these projects were empirically tested.

**Observation and Analysis Of Sport Skills**

Stadulis (1972) proposed coincidence-anticipation as a system of teaching and analyzing skills involving the interception of a moving object through space. Coincidence refers to making the correct motor response that enables the learner to arrive at the proper intercept point with the object. Anticipation refers to executing the motor response prior to the arrival of the object at the intercept point. The three distinct phases of coincidence-anticipation include a pre-release phase of the object, flight phase of the object, and a response phase to the object. Stadulis outlines the information processing schema the recipient performer proceeds through during each phase.

The second component of the coincidence-anticipation model is developmental sequence analysis where skills involving interception of an object are studied across stages of development from early childhood through adulthood. Thus, Stadulis (1972) calls for the study and analysis of not only adult skilled performers, but subjects representing different ages and levels of ability so that important elements of
performance are not overlooked. The study and understanding of sequential skill development serves as a foundation for teaching and analyzing such skills.

Finally, Stadulis (1972) points to the fact that skills falling into the coincidence-anticipation category possess their own unique performance elements and that too few elements have been identified and too few developmental analyses have been conducted for the enormous number of motor skills physical educators teach. The coincidence-anticipation model has not been empirically tested.

Vanderbeck (1979) brings to light the lack of information and the absence of organized approaches in the aquatic literature for observing and correcting errors in swimming skills. One of the major problems and remedies generic to analysis of all sport skills is stated by Vanderbeck (1979) as follows: "Because there are so many errors which may occur in the performance of any given skill, the novice teacher will be better prepared to identify those which do appear if he/she has a preconceived and functional understanding of what to look for" (p. 55). Her observational system, designed to help teachers and coaches detect errors in the front crawl stroke, is based on: (1) understanding hydrodynamics and efficient swimming skills, (2) understanding the limitations of the human body moving through water, (3) use of head on, side, and rear views of the swimmer from pool side, and (4) the use of a flow chart of Common Error
Patterns in the Front Crawl (Vanderbeck, 1979). The flow chart contains eleven major front crawl stroke errors and 43 possible causes, labeled by number, and connected by arrows. Use of the system was not empirically verified.

Vanderbeck (1979) notes that, "The definition of a performance error is premised on the definition of a correct performance" (p. 54). It would appear that any aberration or deviation from a correct performance is to be considered an error. A review of most any text on any given sport shows that most attention is given to descriptions of correct performance while information regarding errors is minimal.

McCormick, Subbaiah, and Arnold (1982) devised a method of identifying components of the front dive half twist in an effort to establish an objective criteria for judging springboard diving. Twenty-six divers at the 1979 Men's Amateur Athletic Union prequalifying meet at The Ohio State University were videotaped. Clear plastic grids used to measure body angles and splash height were placed on a video monitor. The position of the diver's body was stopped at thirteen different positions during the dive to measure each component according to a well defined and illustrated set of criteria. A subset of the thirteen variables was used in a Stepwise Multiple Regression Analysis to formulate a prediction equation to predict the scores of the judges. The equation used the height of the dive, twist, the lower body
angle at the point where the diver's head was even with
the board, and the distance away from the board as variables
for the equation. The scores of the judges were predicted
with a multiple correlation coefficient $r = .80$.

The researchers suggest that such a system could be used
to train judges to pick out the important elements of a dive
to become more objective scorers. They also suggest that
this system would provide a way for judges to update their
judging skills as well as aid coaches in helping train divers
by pointing out the important components of a dive.

McGill (1982) developed a model for observation and
analysis of sport skill performance based on the premise
that teachers and coaches mentally replay what they observe
and compare the mental replay to a standard of performance
also formulated and held in the mind. "Mental replay...is a
term used to describe a person's ability to watch another's
motor performance and then replay what was seen in their
'mind's eye'" (McGill, 1982, p. 1). To complete this model
teachers and coaches must develop a mental template of ideal
performance to compare the replay against. McGill notes
that standards of performance or mental templates differ
among coaches for the same skill. Therefore, standardiza-
tion of mental templates is necessary. According to McGill
(1982), mental templates of ideal sport performance are based
on the performance points or critical elements identified
through a seven step process presented in Figure 1.
I. Watch
  View Ideal Performance on Video Tape

IIa. Perform
  Copy Ideal Performance With All Equipment Except a Moving Ball

IIb. Perform
  Copy Ideal Performance With All Equipment

IV. Write
  Describe Ideal Performance in Words

V. Write
  Arrange Description in Chronological Order

VI. Write
  Determine the Most Important Points/Parts of the Skill

VII. These Points/Parts Will be Called... Critical Elements

Figure 1. Flow Chart for Standardizing Motor Skill Mental Templates. (McGill, 1982)
Once the critical elements have been established teachers and coaches must practice instant recognition of the elements and make comparisons with the mental template. "This process could be likened to comparing photographs for difference in body position, but, the coach must accomplish the task in his mind" (McGill, 1982, p. 5).

The observer may proceed by observing the entire skill and then check off each critical element in proper order from beginning to end, detecting errors and making corrections to the learner. Or, the observer may start with the last critical element and check them off proceeding back to the first. In either case, the error detected earliest in the performance should be corrected first. This model has not been empirically tested.

Gangstead (1982) conducted research in qualitative sport skill analysis using naked eye observational procedures originally established by Cooper, Adrian, and Glassow (1972), and later refined by Davis and Knight (1977). The observational framework of the model is presented in Figure 2. When beginning the observation of repeated skill attempts the observer focuses attention on the temporal phasing components of the model by noting how movements begin and end each of these phases. Then the observer's attention is directed to the left side of the model where spatial dimensions of movement are listed. Body components of the performer are observed starting with "Path of Hub" and working down the
<table>
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<th>COMPONENTS</th>
<th>TEMPORAL PHASING</th>
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<tr>
<td></td>
<td>Preparatory</td>
</tr>
<tr>
<td>Path of Hub</td>
<td></td>
</tr>
<tr>
<td>Body Weight</td>
<td></td>
</tr>
<tr>
<td>Trunk Action</td>
<td></td>
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<td>Head Action</td>
<td></td>
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<tr>
<td>Action of Legs</td>
<td></td>
</tr>
<tr>
<td>Action of Arms</td>
<td></td>
</tr>
<tr>
<td>Impact/Release (Hand, foot, implement)</td>
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</tr>
<tr>
<td>Summary of Effectiveness</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Observational Model.

Myron Davis (Weber State University, Ogden, Utah) formally developed this model based on an analytical process discussed in J. M. Cooper, M. Adrian, & R. B. Glassow, (Eds.), (1972). Kinesiology (3rd ed.). St. Louis, MO: C. V. Mosby Company.
list. In this model the hub represents the trunk of the performer's body and, therefore, the slowest moving part of the anatomy. The observer's attention is then gradually directed outward to the faster moving extremities of the body. This model helps the observer establish a systematic viewing pattern and was designed with the purposeful recognition that performance errors detected in the extremities may very well be associated with movement problems originating at the hub of the body, i.e., faulty trunk rotation, improper weight transfer, or defective hub movement (Gangstead & Beveridge, 1984).

Gangstead (1982) empirically tested the model using a pretest-posttest with control group experimental design to measure the effects of instruction devised to enhance sport skill analytic proficiency. Components of analytic proficiency included a perceptual variable and a diagnostic variable. The Utah Skill Analysis Test (Gangstead & Beveridge, 1982) was used to measure the analytic ability of 40 University of Utah physical education majors. The test incorporates a videotape format utilizing authentic performances of select motor skills. The experimental group learned to visually and verbally employ the spatial and temporal components of the model through training sessions of one hour duration; three times a week for eight weeks. A significant difference was measured between the experimental and control group on each variable examined
(p < .002). Also, an interesting correlation between perceptual ability and diagnostic ability showed no significant relationship (p > .05).

The review of the skill analysis observation training models reveals that few exist and that even fewer have been empirically tested. This may very well be a reflection of the way physical education is taught. Hoffman (1971) points out that the traditional method of teaching physical education (command teaching, controlling students, stressing neatness, and order) depends very little on a teacher's analytic ability. As a major advocate of sport skill analysis training, Hoffman (1977a) calls for competency-based training in skill analysis. Furthermore, Hoffman (1982) suggests that clinical diagnosis of sport skills should be taught as a pedagogical skill. He presents the analogy that just as a physician makes decisions about the treatment of a patient, the teacher must also diagnose a student learning a skill and provide appropriate kinds of feedback and prompts.

**Recognition Training**

Allan (1958) provides an historical overview of the different kinds of aircraft recognition training programs that were designed prior to and during World War II to train military and nonmilitary personnel to identify aircraft. At that time, long range visual identification of aircraft was obviously crucial to defense and that period marks the first
time that recognition was addressed as a topic of formal instruction. Because recognition training had never been dealt with, early instructional efforts were based on conjecture as even psychology provided few useful guidelines.

The first recognition training program took place in England in 1940. The first instructors were expert spotters or people that had an interest in aircraft and were skilled observers, but were unable to explain how their skills were acquired. As Allan (1958) points out, "It was something that had grown, apparently as a by-product, from an early interest in aircraft; how to transmit that skill to others was something of a problem" (p. 246). The early training efforts in England were based on studying a plan view, side view, and head-on view of the aircraft and committing to memory various details.

In the United States, from 1940 to 1942 the WEFT (wings, engines, fuselage and tail) system was being utilized. This was a systematic visual analysis approach designed to assist memorization. But, the WEFT system was unsuccessful because it required too much rote learning.

At about the same time, Dr. Samual Renshaw of Ohio State University introduced a recognition training system which featured total forms of aircraft flashed on a screen requiring split second identification. The Renshaw system or flash system was utilized briefly by the U.S. Navy and Air Force without being empirically tested. Eventually the flash
system was discarded when it was realized that accurate observation over long distance was more important than speed of recognition.

The Sargent aircraft recognition training system, named after Charles Sargent, employed an entirely different approach to train for aircraft identification. Sargent viewed recognition as a perceptual learning process that could be acquired naturally. This position is clearly described by Allen (1958):

Obviously the human organism possesses a mental mechanism capable of carrying out perceptual organization without the aid of lectures or formal instruction, otherwise there would be none of the spontaneous recognition skills of everyday life, such as the ability to recognize faces and objects. The problem is how to stimulate this perceptual organizing capacity into action. (p. 247)

Based on the perceptual organization premise, the Sargent system does not utilize formal lectures or presentation. Instead, students work from a book of key pictures to identify aircraft in a second book of aircraft photographs. Students write the name of the plane when properly identified, work at their own pace, and are free to consult with other students. The instructor acts not as a formal teacher, but as a resource person, answers questions and supervises study efforts. The Sargent system proved to be an effective training method for recognition of aircraft.
Allan (1958) empirically tested the Sargent system. Subjects were drawn from a class of recruits undergoing light anti-aircraft basic training. The experimental group included 62 men that were trained using the Sargent system. The control group included 62 men trained to recognize aircraft by the conventional lecture/presentation teaching format. At the end of the training period, each group was administered a 20-item spotting test. The experimental group demonstrated superior ability to recognize aircraft significantly at the five percent level. Allan reports that the commanding officer of the unit the men were tested in reported students were very enthusiastic about learning via the Sargent system and that interest was so high that recruits were often reluctant to leave the class at the close of a training period.

The strategies underlying these training methods can be divided into part (distinctive features) vs. whole learning. The flash system was based on Gestalt or whole learning. Kohler (1947) states, "In German, the word Gestalt is often used as a synonym for form or shape" (p. 177). Thus, the flash system emphasized total form without reference to features or parts. In short, Gestalt theory is based on the premise that perceptions (in this case of shapes) are not learned, but perceived directly. Hebb (1949), however, disputes Gestalt theory; he states, "...'simple' perceptions are in fact complex: that they are additive, that they depend
partly on motor activity, and that their apparent simplicity is only the end result of a long learning process" (p. 17). It is believed that just such a process was brought into play as students in the Sargent training system were learning to discriminate features that belonged, or did not belong to various shapes and thus were better able to discriminate one aircraft from another. Advancements in military observation discrimination training tend to support learning initial features in relation to the whole.

Bramley (1973) conducted military research to determine if visually discriminating wholes or individual features was the most effective training method to facilitate tank recognition. Early efforts in military recognition training systems emphasized recognition of complete shapes of aircraft against plain backgrounds; however, because of technology, the actual aircraft or ship is viewed most often on sonar or radar where the image is degraded or blurred. Accordingly, a similar situation exists when attempting to visually identify ground equipment including tanks, armoured cars, rocketlaunchers, etc. because they are often camouflaged and therefore represent a degraded image.

In this study, four different training methods to facilitate tank recognition were compared. Method A was based on discriminating the whole vehicle, in this study the Soviet T-62 tank. A training booklet of 60 possible targets contained a front and side view of each tank, 30 of which were
the T-62 and 30 more were similar tanks. Subjects had to compare the booklet pictures with keys (whole pictures of the T-62 tank) and with "T-62" or "No" on an answer sheet. The task was made more difficult as the test booklet pictures were photocopies of tanks taken from magazines and therefore were purposefully degraded images. Method A allowed subjects to view details in relation to the whole tank and select their own cues. Training Method B required subjects to identify the T-62 tank based only on key recognition features as the key photographs were cut up leaving only the most important critical features. Thus, subjects were required to discriminate the T-62 tank from similar tanks based on distinct details without the whole configuration. Training Method C provided subjects with the whole tank configuration; cues or critical features, and labels to assist recognition of the most important identifying features. Training Method D was organized the same as Method C, however, an additional requirement was made as subjects had to answer six questions regarding details of the tank before a "T-62" or "No" answer was recorded. Unlike the other methods, Method D required the subject to learn the cues or critical features rather than just drawing attention to them.

Subjects included 36 inexperienced officers, 36 junior NCO's and 36 infantry recruits. The experiment was conducted separately for each group of subjects. Within each group,
nine men were randomly assigned to one of the four training conditions. Recognition/recall tests were conducted 15 minutes and 90 minutes after training. Results were displayed in a table of mean scores for each training method under the respective 15 and 90 minute testing times for officers, NCO's and recruits. The data were treated with a two-way analysis of variance. A significant difference was determined between the 15 minute test scores and the 90 minute scores, however, there was no statistical difference between the three groups of soldiers. An analysis of the differences between training methods showed Method D to be the most effective means of training with no established differences between Methods A, B, and C. Bramley points to the fact that Method D was the superior discrimination training format because it required active learning of the critical features by the subject. Method A left discovery of the critical features to the subject. In Methods B and C, the critical features were pointed out with the assumption made that subjects would use them as cues.

This study highlights the importance of incorporating active rather than passive learning in an observation discrimination training program.

Elliott, Wills, and Goldstein (1973) researched the effects of subjects' ability to recognize white and oriental faces based on discrimination training. In effect, the study was designed to test the differential experience
hypothesis which states that subjects are better able to discriminate facial features of people within their own race over faces from other races based on experience and the opportunity to develop cue utilization habits.

Sixty-six white students from a Midwestern university were selected as subjects and randomly assigned to one of six groups as follows: (1) white practice/white recognition, (2) white practice/oriental recognition; (3) oriental practice/oriental recognition; (4) oriental practice/white recognition; (5) no practice/white recognition; (6) no practice/oriental recognition. Each subject was individually tested on a PA recognition task involving 30 white and 30 oriental full-faced black and white photographs.

Results showed that group 5 (no practice/white recognition) scored significantly higher recognition scores than group 6 (no practice/oriental recognition) which was expected. Group 3 (oriental practice/oriental recognition) scored significantly higher recognition scores than group 4 (oriental practice/white recognition). The results confirm the differential experience hypothesis. The researchers suggest that discrimination training helped white subjects complete an already partially developed schema for oriental face recognition. In short, discrimination training helped subjects develop knowledge of the class of oriental faces.
Summary

A literature review of sport skill analysis research, models to enhance sport skill analysis, and observation discrimination training lead to the following conclusions:

1. An internally held standard of performance described as a mental image serves as a criterion against which observed performances are compared and analyzed.

2. Exactly how mental images are used in sport skill analysis remain unclear, however, vivid mental imagery may facilitate analytic ability.

3. Kinesthetic experience in sport skills appear to provide no significant advantage in analyzing skills.

4. Actual practice or experience in analyzing sport skills leads to improved analytic ability and may enhance analytic ability more than formal training courses in biomechanics or kinesiology as they are presently structured.

5. Observation discrimination training may prove to be an effective pedagogical tool to facilitate naked eye analysis of select sport skills.

6. Observation discrimination training appears to be most successful when subjects are actively involved in the learning process, and when critical features or critical elements are related to the whole configuration being analyzed.
CHAPTER III

METHODS AND PROCEDURES

Chapter III is divided into eight sections: subjects, test videotape construction, training videotape construction, testing of subjects, establishment of criteria on test and generalization videotapes, reliability testing of the test and generalization videotapes, data collection and reliability, and research design.

Subjects

Subjects for this study were college juniors and seniors majoring in physical education at The Ohio State University. Five women and four men volunteered to participate in return for one credit hour of Physical Education 693 Independent Study, spring quarter 1984. Each subject read and signed an informed consent research form in compliance with the guidelines established by the Human Subjects Committee of The Ohio State University. A copy of this form can be found in Appendix A. Prior to the study each subject completed a personal history profile summarized in Table 1. Background information concerning each subject includes (1) sex, (2) age, (3) college standing, (4) major, and (5) years of physical education taken prior to attending college.
Table 1

Subject Background Information

<table>
<thead>
<tr>
<th>Subject</th>
<th>Sex</th>
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<th>College Standing</th>
<th>Major</th>
<th>Years of PE (K-12) Prior to College</th>
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<td>P.E.</td>
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<tr>
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<td>M</td>
<td>22</td>
<td>Junior</td>
<td>P.E.</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>25</td>
<td>Senior</td>
<td>P.E.</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>21</td>
<td>Junior</td>
<td>P.E.</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>23</td>
<td>Senior</td>
<td>P.E.</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>22</td>
<td>Senior</td>
<td>P.E.</td>
<td>13</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>20</td>
<td>Junior</td>
<td>P.E.</td>
<td>13</td>
</tr>
</tbody>
</table>
Test Videotape Construction

The four sport skills selected for this study were the standing long jump, overarm throw, batting from a tee, and the cartwheel. These skills were chosen because (1) they were closed skills representing predictable movement requirements within a fixed environment (Poulton, 1957), and (2) these skills were common to most physical education classes from elementary to college level.

The comprehensive review of the literature was conducted for each skill, and the researcher selected five of the most important and commonly cited performance points or "critical features" (Barrett, 1979) for each skill. These performance points or critical features will be referred to as "critical elements" and represented aspects of skilled performance the researcher wanted the subjects to attend to while analyzing the skill. In turn, the critical elements were identified with brief verbal labels and listed in chronological order from one to five to match their actual occurrence when the skill is properly performed (see Table 2).

The critical elements for each skill were defined in observable and measurable terms. This information was presented in a one-page personalized system of instruction handout for each skill. Stick figure diagrams were incorporated when necessary to provide clarity (see Appendix B).

Permission was granted by the respective principals and
<table>
<thead>
<tr>
<th>Standing Long Jump</th>
<th>Overarm Throw</th>
<th>Batting From Tee</th>
<th>Cartwheel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Deep crouch</td>
<td>M 1. Step with opposition</td>
<td>Y/N 1. Bat cocked behind head or shoulder</td>
<td>Y/N 1. Lead foot established</td>
</tr>
<tr>
<td>2. Arms behind back</td>
<td>Y/N 2. Open up</td>
<td>Y/N 2. Step into the swing</td>
<td>Y/N 2. Lunge</td>
</tr>
<tr>
<td>3. Full body extension at 45 degree angle</td>
<td>M 3. Full forward rotation of body</td>
<td>Y/N 3. Full forward body rotation</td>
<td>Y/N 3. Hand, hand foot, foot pattern</td>
</tr>
<tr>
<td>5. Deep crouch landing with arms in front of body</td>
<td>Y/N 5. Weight transfer from back foot to front foot</td>
<td>Y/N 5. Swing is basically horizontal</td>
<td>Y/N 5. Finish in balanced side stand</td>
</tr>
</tbody>
</table>

\(M = \) Measurement with clear plastic, fine tip marker, and protractor on TV monitor for confirmation of correct, incorrect or missing element with slow motion and static image control.

\(Y/N = \) Yes/no visual analysis confirmation of correct, incorrect or missing element with slow motion and static image control.
physical education teachers in two different middle schools in the Columbus, Ohio area to videotape sixth, seventh, and eighth grade boys and girls during regularly scheduled physical education classes. A total of two hundred students were videotaped individually in a specially partitioned area of the gymnasium to avoid possible audience effects on performance.

A portable Panasonic VHS color videotape camera and tapedeck were used to videotape all students. A twelve foot by nine foot off-white muslin backdrop was hung between two volleyball standards to provide a viewing background of uniform color and to eliminate distracting visual stimuli. Students to be videotaped were centered at a starting line of masking tape one foot in length on the floor at the center of and perpendicular to the middle of the backdrop. Students were positioned on this starting line with three to four feet of clearance from the backdrop to exclude any interference with or movement of the muslin.

The camera was secured to a tripod positioned in line with, but fifteen to eighteen feet away from, the center of the starting line tape mark. The tripod was vertically adjusted to elevate the camera four-and-a-half feet to five feet off the floor. The horizontal adjustment was loosened to allow slight right and left movement to accommodate student movement during taping. The zoom lens was adjusted to make each student appear as large as possible on the camera’s
monitor without cutting off the head or feet or excluding any body parts during execution of the skill.

For the initiation of each skill the camera was moved slightly to the right making the student appear in the left third of the camera's monitor. Therefore, little or no camera movement was needed to follow the student as he/she moved while performing a skill. Differing student height required continuous zoom lens adjustment.

Equipment required by students was minimal. Students performed cartwheels on a mat, used a black plastic bat, plastic ball, and batting tee for batting, and threw a whiffle ball. The plastic bat and balls afforded students the opportunity to attempt batting and throwing with maximum force production, yet were safe to use in the gymnasium.

Prior to taping, standard verbal instructions were given by an assistant to each student performing the same skill. In each case the instructions were a request to perform the skill as well as possible. Wickstrom (1977) indicates that a full effort on the part of the performer is necessary for reliable analysis, as too little or too much effort leads to a distortion of the skill. Therefore, directions were given as follows:

1. When I say go, please jump as far as you can.
2. When I say go, please hit the ball as hard and far as possible.
3. When I say go, please throw the ball as far as possible.
4. When I say go, please perform your best cartwheel.

Three visits were made to each middle school for videotaping. In each case, the first visit was arranged to explain the taping process to cooperating teachers, establish shooting schedules, and practice videotaping.

The actual videotaping of students was carried out by arranging the environment, utilizing the equipment, and giving verbal instructions as previously described. Following each performance the camera was left on seven to ten seconds simply recording the backdrop to allow enough blank tape between subjects for future videotape editing.

After videotaping two hundred subjects, the researcher reviewed the tapes and selected performances to be edited for the final test tape based on the following criteria:

1. clear confirmation of critical elements had to be made as correct, incorrect, or missing...
2. the tape had to be clear with no blurring, or bouncing...
3. each shot had to have good lighting and color...
4. the student performing had to occupy two-thirds or more of the vertical height of the TV monitor to provide a satisfactory viewing picture.

Time was recorded on each tape by voice, giving minutes and seconds as locator cues which provided a means of identifying and locating each student. For example, five minutes ten seconds was the locator cue to advance or rewind the tape to in order to locate student number seven. A master
form was devised for each skill (see Appendix C) listing the critical elements and providing space to record the locator time cue in minutes and seconds, sex of the student, and distinguishing dress characteristics for additional identification. The use of slow motion and step action videotape equipment allowed for visual inspection and measurement of a student's ability to perform the critical elements of a skill. When viewing the standing long jump the image on the TV monitor was controlled to the desired static position. Then a clear plastic sheet was placed on the monitor; straight lines were drawn through the middle or length axis of the desired body segments and a protractor was used to determine degrees of flexion, or extension for critical elements one, three, and four (see Table 2). The remaining elements for the standing long jump, throwing batting, and cartwheel, were visually inspected and confirmed with a yes or no. Therefore, correct execution of a critical element was indicated with a yes. Incorrect execution of a critical element was indicated with a no. Throughout the study, incorrect and missing critical elements (elements not performed in a skill) were considered one in the same and scored with a no for incorrect (see Table 2).

After evaluating all preliminary tapes, sixty performances met the previously described selection criteria. Fifty-six of those performances were randomly selected for final editing to make the test videotape. The test videotape
was constructed by editing student performances onto three quarter inch color videotapes in the order called for in the multiple baseline research design utilized in this study for sessions one through five.

The test videotape included sixteen students doing the standing long jump, fifteen students throwing a whiffle ball overarm, fourteen students batting from a tee, and eleven students performing a cartwheel.

Performances within each of the skill groups showed instances of the skills being performed with all critical elements correct, all elements incorrect, or a combination of correct and incorrect elements. This simulates the variation of sport performances naturally occurring in teaching and coaching. Table 3 shows the order of skills presented as well as the elements performed correct and incorrect in each skill throughout the test videotape.

Each student performance was recorded three times at normal speed to allow the subject the opportunity to view three consecutive replays of the same student performing the same skill. Each instant replay was separated by two to three seconds of blank tape which appeared black to the viewer. Each set of three replays of the same student was separated by seven seconds of blank tape. During these intervals, a voice recording was made identifying the session number and student number. For example, session
### Table 3

Order of Skills Presented on Test Videotape With Number of Critical Elements Correct/Incorrect Per Skill

<table>
<thead>
<tr>
<th>No. of Skills Presented on Tape Per Session</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>J-3/2</td>
<td>J-4/1</td>
<td>J-0/5</td>
<td>J-4/1</td>
<td>J-0/5</td>
</tr>
<tr>
<td>2</td>
<td>J-0/5</td>
<td>J-0/5</td>
<td>J-1/4</td>
<td>J-1/4</td>
<td>J-4/1</td>
</tr>
<tr>
<td>3</td>
<td>J-4/1</td>
<td>J-2/3</td>
<td>J-3/2</td>
<td>T-4/1</td>
<td>T-1/4</td>
</tr>
<tr>
<td>4</td>
<td>J-2/3</td>
<td>J-1/4</td>
<td>J-4/1</td>
<td>T-5/0</td>
<td>T-2/3</td>
</tr>
<tr>
<td>5</td>
<td>T-1/4</td>
<td>T-3/2</td>
<td>T-2/3</td>
<td>T-1/4</td>
<td>B-4/1</td>
</tr>
<tr>
<td>6</td>
<td>B-2/3</td>
<td>T-5/0</td>
<td>T-1/4</td>
<td>T-2/3</td>
<td>B-1/4</td>
</tr>
<tr>
<td>7</td>
<td>C-3/2</td>
<td>T-2/3</td>
<td>T-5/0</td>
<td>B-5/0</td>
<td>B-2/3</td>
</tr>
<tr>
<td>8</td>
<td>T-3/2</td>
<td>T-2/3</td>
<td>B-3/2</td>
<td>B-5/0</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>B-5/0</td>
<td>B-2/3</td>
<td>B-1/4</td>
<td>C-2/3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>C-0/5</td>
<td>B-4/1</td>
<td>B-4/1</td>
<td>C-4/0</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>B-5/0</td>
<td>C-3/2</td>
<td>C-0/5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>B-3/2</td>
<td>C-2/3</td>
<td>C-0/5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>C-4/1</td>
<td>C-5/0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>C-4/1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*J = Jump*  
*B = Bat*  
*T = Throw*  
*C = Cartwheel*
one, student one. After completing the test tape, it was checked for production errors and a copy was made on half-inch VHS color videotape.

Construction of Intervention
Training Videotapes

The design of the training videotapes was based on the following production goals:

1. the program must be very specific...

2. the training tape should help students clearly identify the critical elements and most common performance errors associated with each skill, i.e., failure to perform the element or a major aberration of the element...

3. effective use of the videotape medium must be made by use of slow motion, and instant replay shots concise...

4. verbal narration, and printed cue words.

The actual design of the training videotapes began with the construction of a storyboard (Heinich, Molenda, Russell (1982) where narration and scene-by-scene shots were described and drawn on three inch by five inch white index cards and displayed in order on a large sheet of cardboard (see Figure 3). The original storyboard was designed for the production of the standing long jump training videotape. The format for this videotape became the template or production format for the throwing, batting, and cartwheel training tapes. Only the model performers, critical elements,
and student performance examples were changed as the format for each training videotape remained the same.

The original storyboard for the standing long jump was evaluated independently by three professors from the Physical Education Department at The Ohio State University. These evaluators were selected for their respective expertise in instructional design, motor learning, and sport teaching. Finally, a professor in the College of Education Teacher Education Laboratory, skilled in videotape production, evaluated the storyboard. The recommended changes were made and approval for production was granted by each of the evaluators.

The researcher then invited male and female college students highly skilled in track and field, gymnastics, and baseball to serve as model performers for the standing long jump, overarm throw, batting, and cartwheels. These model performers were videotaped in the gymnasiunm of Pomerene Hall at Ohio State using the same equipment and environmental arrangements used when videotaping students in the middle schools.

The tapes were evaluated according to the established criteria for critical elements in each skill. Four different students were selected as model performers. Models included one female thrower, one female performing cartwheels, one male performing the standing long jump, and one male batter.
All further work and film production was conducted in the Teacher Education Laboratory at Ohio State.

The production of four ten minute instructional videotapes and the test videotape of fifty-six different subjects, instant replayed three times each, required eighty-six hours of production time at a cost of twenty dollars an hour. This service was free of charge to faculty and graduate students.

The researcher used one-half inch VHS color videotape for the recording of test tape students and model performers. The editing equipment in the Teacher Education Laboratory at The Ohio State University was equipped for editing three-quarter inch VHS color videotape. Therefore, a master tape was made on three-quarter inch videotape and then copied on one-half inch tape. See Appendix D for the standing long jump training videotape script.

**Testing Procedures**

Each of the nine subjects attended five private (subject and researcher only) testing sessions and one group testing session for generalization. All testing was completed within a two-week period with each subject attending Monday, Wednesday, and Friday testing sessions both weeks. Subjects were requested not to discuss the project or view materials that might enhance their understanding of information presented during the study.
Testing for the first five sessions was conducted in private in the Teacher Learning Center in the basement of Richard Larkins Hall. Experimental isolation was maintained in a windowless concrete room measuring eight feet wide by twelve feet long. Subject sat in a classroom desk-chair positioned in front of a nineteen inch color TV monitor placed on a table measuring thirty inches in height. The viewing distance from subject to monitor was forty inches. The researcher sat five feet behind the subject and controlled the presentation of the test videotape on the TV monitor by remote control.

At the start of the first session, subjects read a set of instructions (see Appendix E) for viewing the test videotape. The instructions directed subjects to observe the three instant replays of a student performing a sport skill at normal speed on the TV monitor. After observing the third trial, subjects were requested to immediately list on an answer sheet (see Appendix F) what they considered to be the five most important critical elements and indicate, by circling C or I, whether each elements was correct (C) or incorrect (I). Subjects were given a two-and-one-half minute time limit to record their responses.

When training videotapes were introduced in the intervention phase of the study, subjects were given directions for viewing the training tapes (see Appendix G) that requested subjects to study the tape carefully and use the
acquired information as specifically as possible. Subjects were also given a one-page study guide (see Appendix B) immediately after viewing a training tape. The study guide provided both clarification of material presented in the training tape as well as a review of the critical elements to enhance learning. Subjects could view all or any part of the tape more than once. Furthermore, subjects were requested to study at their own pace. Thus, study of the training tapes was based on a personalized system of instruction known as PSI (Keller, 1968).

The sixth (and final) testing session for generalization was conducted in a Columbus area middle school to test subject's ability to generalize what they learned, in the five previous sessions, to a real school setting with live un-rehearsed performances by sixth grade students. A sixth grade class was chosen for analysis over seventh and eighth grade classes based on the assumption that less mature students would probably provide more variation in performance.

Generalization testing was conducted during a regularly scheduled physical education class. The sixth grade class and students chosen to perform the skills were selected at random.

Subjects were told that the last testing session would be conducted in an area middle school. They were naive with regard to the identity of the school and testing circumstances. Again, subjects were reminded not to discuss the
project, especially as they traveled to the school; the researcher and an assistant provided the transportation.

Appendix H shows the arrangement of equipment and subjects for viewing student performances for generalization testing. Equipment was set up, and subjects took their positions for viewing. As indicated in Appendix H, subjects sat in three rows. Subjects in the back row sat on metal folding chairs, subjects in the middle row sat on eight inch thick, folded mats, and subjects in the first row sat on fully extended folding mats. This stairstep effect was designed to provide each subject unobstructed viewing access of each performance within a limited amount of space.

A wall partition was drawn across the gymnasium to provide privacy for each sixth grade student performing a skill as well as eliminate distractions for the nine subjects making the analysis. A videotape camera was set up as originally described in the recording of the test videotapes. Again, a tape line was applied to the floor, as originally specified, as a starting point for the execution of skills. The same plastic bat, ball, batting tee, and mat were used in the same fashion as in the original test videotapes.

Each subject received a packet including sixteen test forms, pencils and a lapboard for a firm writing surface. Subjects were allowed to remove one answer sheet (see Appendix F) from the packet at a time to prepare for each viewing. As in the lab, subjects were given a time limit of
two and one-half minutes to make their analysis following each performance.

Sixth grade students entered the testing area one at a time in the following order:

1. four jumpers,
2. four throwers,
3. four batters, and
4. four students performing cartwheels.

Each student performed the requested skill one time, according to the directions of the assistant. These were the same verbal directions given to prompt skill execution during the test tape recordings. There were no breaks or rests. Subjects turned their answer sheets over as soon as the analysis was completed. When the last subject was finished with an analysis, or the time limit was reached, answer sheets were immediately collected and a new student entered the testing area to demonstrate a skill.

Following completion of the testing for generalization, the researcher scored the videotape of the sixteen students performing skills by using the established criteria of critical elements for each skill as well as slow motion and stop action measurement as was done for the original test videotape. Student identification data and the results for correct and incorrect execution of critical elements were recorded on the critical element forms (see Appendix C) for each skill. The forms were then added to the fifty-six critical element forms recorded for the baseline and
intervention evaluation of skills for the test videotape. This compilation of critical element forms completed the master key that was used to evaluate subject responses for each skill performance throughout the study.

Establishment of Criteria for Test and Generalization Videotapes

The question can be asked: How might one be sure that the critical elements used as criteria on test and generalization videotapes were correct? It is the purpose of this section to answer that question.

Videotapes allow for estimates of accuracy of observed responses, in this case critical elements of selected motor skills. Johnston and Pennypacker (1980) define accuracy as "the extent to which obtained measures approximate values of the "true" state of nature, perfect accuracy being obtained when equivalence is demonstrated" (p. 190). The researcher attempted to closely approximate the true values for the critical elements through the following procedure:

1. The videotaped performances represented a permanent research product captured by the unbiased, nonjudgmental lens of a videotape camera and recording equipment.

2. The critical elements (defined response classes) were approved by experts of sport skill analysis with knowledge equal to or greater than that of the researcher.
3. The researcher purposefully and carefully chose major body movements to represent critical elements for ease of visual detection. Clear, brief labels were applied to these movements to identify them as critical elements, and each element was clearly defined in the training videotapes and PSI study sheets. "The care and precision with which the response class to be studied is defined contributes directly to the eventual accuracy of measurement. Broad, vague definitions present relentless problems of detection, particularly if human observers are involved" (Johnston & Pennypacker, 1980, p. 193).

4. The presence and/or absence of the expertly defined critical elements in the videotapes were determined through slow motion and stop action analysis of the tapes. Repeated analysis was done whenever there appeared to be any question about an element.

**Reliability Testing of the Test and Generalization Videotape**

Reliability tests were conducted on the test and generalization videotapes to check the accuracy of the researcher's analysis of critical elements recorded as correct or incorrect in the critical element master key. This procedure required a second independent observer. Johnston and Pennypacker (1980) dispute the utilization of a second observer to appraise the accuracy of the first observer, but
believe such a step can be useful with regard to the believability of data:

Believability is the propensity of the experimenters and their colleagues to accept as true any features of the data that are under examination. In the case of measurement variability, believability refers to the extent to which data are assumed to be accurate representations of what actually occurred. (p. 166)

Within this section pertinent reliability information, testing procedures and results are presented.

"Reliability refers to the degree to which independent observers agree on what they see and record" (Siedentop, 1976, p. 37). The formula often used to calculate reliability is:

\[
\frac{\text{agreements}}{\text{agreements} + \text{disagreements}} \times 100 = \frac{\text{percentage of agreement}}{}
\]

Hawkins and Dotson (1978) define agreement and disagreement as follows:

An agreement is any interval in which both observers recorded that the response occurred during the interval, or in which both observers recorded that the response did not occur during the interval. Disagreements are intervals in which only one observer reported that the response occurred. (p. 360)

In this study, intervals are represented by the performances of sport skills by students on videotape. Fifty-six different student performances on the test videotape represented fifty-six intervals. Sixteen different student performances captured on the generalization videotape equaled
sixteen intervals. Responses had to be made to the five critical elements, as correct or incorrect, within each interval by the researcher. Interobserver agreement testing of these responses was conducted as follows.

1. Five critical element measurements were originally recorded on each of the fifty-six master key critical element forms for a total of two hundred eighty critical element measurements recorded as yes for correct critical element execution, or no for incorrect performance for a critical element (see Appendix C). A random sample of two forms was selected from each of the following pools: sixteen jumping performances, fifteen throwing performances, fourteen batting performances, and seven cartwheel performances. As a result, this sample included eight master key critical element forms representing forty different critical element measurements, accounting for 12.5% of the total measurements made for the test videotape.

2. In one session, an independent observer totally unfamiliar with the study observed all four training videotapes and studied the accompanying PSI study sheets.

3. The researcher then demonstrated how to measure body angles for the standing long jump using a clear plastic sheet, felt marker, and protractor, and provided critical element measurement directions.
4. The researcher answered questions posed by the observer regarding the procedures.

5. The observer then analyzed each of the eight randomly selected student performances on the test videotape by conducting his own measurements of critical elements as correct or incorrect. The observer recorded his findings on blank master key critical element forms.

6. The independent observer's measurements were then compared with the corresponding measures in the critical element master key. The results revealed disagreement on five of the critical element measurements out of forty. Therefore, the independent observer and the researcher were in agreement on 87.5% of the critical elements in the sample.

A second reliability test was conducted on the generalization videotape by the same independent observer during the same reliability testing session. Again, it was important to determine the accuracy of the researcher's measurements of critical elements correct or incorrect for student performances for the generalization phase.

All procedures for reliability testing of the generalization videotape were the same procedures used in the reliability testing conducted on the test videotape, however, in this test two critical element forms were randomly selected from a total of sixteen forms. Therefore, this sample accounted for ten critical element measurements out of a total of eighty, representing 12.5% of all generalization
critical element measurements. The results showed the independent observer and researcher agreed on all ten critical element measurements for 100% agreement reliability.

Discussion of Agreement Reliability

Each of the five critical elements disagreed upon, out of the random sample of forty, in the reliability test of the test videotape were examined again using slow motion and stop motion videotape deck controls. A final determination of each element performed correct or incorrect was made as follows:

1. Session Three, Student Five performing the overarm throw. Disagreement occurred on critical element number five: Weight Transfer From Back Foot to Front Foot. This element was recorded as correct in the master key; the independent observer marked it incorrect in the test. His reasoning was as follows. "Technically there was a transfer, although small. However, since there was no opposition, it was transfer from the wrong foot to the other." Opposition was not necessary for weight transfer. The tape clearly showed momentum generated in a forward direction from back foot to front foot. Therefore, this element remained marked correct as originally recorded in the master key.

2. Session Three, Student Nine performing a batting swing. Disagreement occurred on critical element number one: Bat Cocked Behind Head
or Shoulder. This element was marked correct in the master key; the independent observer marked it incorrect during the test. Slow motion and stop action analysis showed the tip of the bat crossing behind the batter's right shoulder and was therefore marked correct as originally recorded in the master key.

3. Session Four, Student Fourteen performing a cartwheel. Disagreement occurred on critical element number one: Lead Foot Established. This element was recorded as correct in the master key; the independent observer marked it incorrect during the test. His reason was as follows: "There was a lead foot established, but it was established via a step backwards with the opposite foot." The videotape shows the student taking a step backward with the right foot to establish a side standing position then step forward with the left foot. As a result, this element remained recorded correct in the master key.

4. Session Five, Student Twelve performing a cartwheel. Disagreement occurred on critical element number three: Hand, Hand, Foot, Foot Pattern. This element was recorded as incorrect in the master key and the independent observer marked it as correct during the test. His reasoning was as follows: "Technically it was there, but placement was off, seemingly because of lack of momentum." Slow motion and stop action analysis showed the lack of momentum, crossing of the legs, and bending of the knees violated this element. Therefore, this
element remained marked incorrect in the master key.

5. Session Five, Student Twelve performing a cartwheel. Disagreement occurred on critical element number four: Body Extended Through the Vertical Plane. This element was correct in the master key; the independent observer marked it incorrect during the test. Slow motion and stop action showed the student upside down in a handstand position with the arms and legs straight. As a result, this element was marked correct as originally recorded in the master key.

Data Collection and Reliability

Subject answer sheets (see Appendix F) collected in baseline, intervention, and generalization phases of the study represented permanent research products that were graded by the researcher against the master key which indicated the performance outcomes for the critical elements performed by each student for each skill on the test videotape. Every subject generated 72 answer sheets for a total of 648 answer sheets for all nine subjects. Answer sheets were always graded by the researcher immediately following a testing session. The data were then plotted on each subject's multiple baseline graph. The results were never revealed to the subjects until the study was completed.

The grading of a subject's responses for the analysis of
a sport skill performance first involved the matching of a subject's written critical elements on the left side of the answer sheet to the established critical elements for each skill in the master key. Failure to write an element by leaving one of the five spaces blank was marked as an error. Furthermore, any written element that was vague or confusing in meaning was marked an error. Following intervention and generalization, subject responses had to conform in wording to the wording of the critical elements presented in the training videotapes and the PSI study sheets. The second step in grading required a matching of the subject's visual discrimination of critical elements performed correct (marked C) or incorrect (marked I) on the left side of the answer sheet against the master key. Answers that did not match the master key were marked an error. Furthermore, no credit was given for visual discrimination decisions when there was no corresponding critical element listed, or when the corresponding critical element was graded as an error. The number of correct responses for verbal (written critical elements) was symbolized with a (·) and plotted accordingly on the subject's graph. The number of correct responses for visual discrimination of critical elements performed correct or incorrect was indicated by a (Δ) and plotted on the graph. In either case, the highest possible score was five.

A third reliability test was conducted to check the accuracy of the researcher's grading of subject answer sheets
during the first five sessions of the study. Each subject produced fifty-six answer sheets for sessions one through five for a total of five hundred four answer sheets for all nine subjects. The following procedures were used to administer the agreement check:

1. The original subject answer sheets for test sessions one through five were numbered consecutively from one to five hundred four and a random sample of fifty-one answer sheets were selected by use of a random numbers table. The sample accounted for 10% or five hundred ten critical elements to be scored out of a total of five thousand forty critical elements originally graded by the researcher for sessions one through five.

2. The answers on the randomly selected answer sheets were recopied on blank answer sheets so the independent scorer would remain naive to the original grading of subjects' critical elements and the corresponding visual discrimination decisions circled C for correct, or circled I for incorrect.

3. The independent scorer studied a PSI study sheet for each skill to understand the wording and meaning of each critical element.

4. Brief directions for scoring answer sheets were presented and the independent scorer commenced scoring each written critical element.

5. After completing the scoring of written critical elements, the independent observer was
given the master key to check the researcher's accuracy of grading the visual discrimination of critical elements against the master key as correct or incorrect.

**Research Design**

The single subject research design utilized in this study is a multiple baseline across behaviors (Baer, Wolf & Risley, 1968) with probes (Thompson, Braam & Fugua, 1982). The main concern in this study was analytic ability. Analytic ability was operationalized by two dependent variables. The first dependent variable was verbal identification of critical elements for each skill. The second was visual discrimination of those elements during performance as correct or incorrect.

The experimental logic of the multiple baseline research design is explained by Baer, Wolf, and Risely (1968) as follows:

> In the multiple-baseline technique, a number of responses are identified and measured over time to provide baselines against which changes can be evaluated. With these baselines established, the experimenter then applies an experimental variable to one of the behaviors, produces a change in it, and perhaps notes little or no change in the other baselines. (p. 94)

The experimenter then applies the experimental variable to a second behavior and records the rate of change in that behavior. This method is maintained until the experimental
treatment has been presented to all behaviors in the study (Hersen & Barlow, 1976). This procedure can be conceptualized as separate A-B designs where the A or baseline phase is further extended for each behavior until the treatment variable is applied (Hersen & Barlow, 1976). Thus, experimental control is demonstrated when introduction of the treatment variable produces a change in the target behavior while other target behaviors remain at baseline levels. To produce such an experimental condition requires the use of independent target behaviors.

A basic assumption is that targeted behaviors are independent from one another. If they should happen to covary, then the controlling effects of the treatment variable are subject to question and limitations of the A-B analysis fully apply. (Hersen & Barlow, 1976, p. 227)

In this study, four independent treatment variables (i.e., four training videotapes) were sequentially introduced to four independent analytic behaviors (i.e., analysis of jumping, throwing, batting, and cartwheels) for each subject and the study was replicated across nine different subjects.
CHAPTER IV

ANALYSIS AND DISCUSSION OF DATA

This chapter is divided into five sections. The first section includes the results and discussion of reliability checks on the researcher's evaluation of the dependent variables in this study. Section two presents a rationale for visual analysis of graphic data. The third section contains the multiple baseline graphed data for each subject along with a brief analysis of each graph and a conclusion regarding the experimental and social significance of the treatment effect. In section four the original research questions are answered. This chapter concludes with a discussion of the study in section five.

Results of Reliability Tests on Data Collection and Evaluation

Chapter three presented a summary of the procedures for data collection and grading of subject verbal responses for identification of critical elements, and visual discrimination responses of elements performed correctly or incorrectly. The methods for conducting reliability tests of the researcher's grading of both types of responses were outlined. This section presents the outcome of those tests.
Results of the reliability tests showed the independent scorer and researcher disagreed on twenty written critical elements out of a random sample of two hundred fifty five critical elements producing 92% agreement. The independent scorer and researcher did not disagree on any of the two hundred fifty five visual discrimination decisions producing 100% agreement.

Discussion of Results

Disparity in agreement for the twenty written critical elements appeared to be due to two factors. First, subjects often wrote vague (i.e., difficult to interpret with regard to exact meaning) critical elements during baseline testing conditions. Clearly the response possibilities in such an exercise are unlimited when subjects are asked to write what they consider to be the five most important critical elements of a sport skill. The disagreements that occurred were due to the researcher and independent scorer's differing interpretation of twenty written critical elements out of two hundred fifty five. Fewer or no disagreements would have been preferred. However, a 92% interscorer agreement reliability demonstrated a high level of specificity for the response class definitions of critical elements used in the intervention training videotapes and PSI study sheets from which subject responses were graded.
The second factor that accounted for disagreement is related to the directionality of the disagreements. Analysis of each disagreement showed the independent scorer was consistently unwilling to accept each of the twenty disagreed upon critical elements as meeting the established definitions of critical elements used in the intervention training videotapes and PSI study sheets. This trend demonstrates that the independent scorer was a slightly more stringent grader of critical elements than the researcher, and that each grader established a uniform grading pattern. These two factors and the resulting 92% agreement reliability show that the subjective nature of the grading task was well accounted for, but not completely eliminated.

Finally, the results of the reliability tests reveal that baseline data most likely represent a slight over-estimation of subject ability to analyze sport skills. This condition will make any effect in intervention and/or generalization over baseline data more impressive.

The Visual Analysis of Graphic Data in Single Subject Research

In single subject research, the graph holds particular importance because it serves as a very complete means of recording and storing data, and analyzing a graph provides evidence indicative of a functional relationship (Kratochwill, 1978). This analysis is primarily a visual
process whereby determination of any change must be of sufficient magnitude to be perceptible to the eye (Parsonson & Baer, 1978).

In the visual analysis of graphed data, differences between baseline and experimental conditions have to be clearly evident and reliable for a convincing demonstration of stable change to be claimed, and audiences will differ in whether or not they are convinced. In order to produce a visible change in the data, an effect would probably have to be more powerful than that required to produce a statistically significant change. (p. 112)

"The purpose of applied research is to effect meaningful clinical or socially relevant behavioral changes" (Hersen & Barlow, 1976, p. 37). Thus, significance in applied behavioral research is based on the magnitude of behavioral change within individual subjects which represents a distinctly different strategy from the more traditional statistical significance, most often employed with between groups comparison of group means. Hersen and Barlow (1976) summarize this difference by explaining that applied interventions endeavor to produce changes that exceed statistical significance by the use of independent variables which most often bring about dramatic changes. According to Hersen and Barlow (1976), the experimental significance of the multiple baseline across behaviors can be established when the following conditions are met: 1) data plotted during the intervention phase may not overlap with baseline
scores, 2) data points of the baseline may not extend to the level of the intervention data, and 3) baseline data must be stable and show no trend toward the desired target behavior.

Interpretation of the graphed data in this study by visual analysis was also facilitated by the guidelines Tawney and Gast (1984) specify:

...(1) the number of data points plotted within a condition, (2) the number of variables changed between adjacent conditions; (3) level stability and changes in level within and between conditions, and (4) trend directions, trend stability, and changes in trend within and between conditions. (p. 161)

The traditions of behavior analysis of graphic data are biased toward Type II errors (i.e., claiming there was no difference when in fact there was a difference). This feature of single subject research differentiates it from more standard statistical analysis approaches. Baer (1977) explains "...much smaller and less consistent differences can be validated by computation than by inspection" (p. 169). In short, visual detection of changes is not as sensitive a measure as statistical detection thereby producing more Type II errors than Type I errors. This may very well be an advantage to the single subject researcher because strong changes in the data are perceptable to the eye. Hersen and Barlow (1977) point out that repudiation of
statistical criteria must be considered with regard to the
goal of applied behavior analysis which is the use of
powerful interventions that yield unambiguous effects
thereby making statistical analysis unnecessary.

Graphed Multiple Baseline
Subject Data

To aid interpretation of the data, a bar graph accom-
panies each subject's multiple baseline graph. The bar-
graphs represent the data as percentages of critical ele-
ments identified correctly verbally and discriminated
correctly visually. Furthermore, Tables 4 and 5 provide
the mean number of critical elements correctly identified
verbally and correctly discriminated visually. Tables 6
and 7 provide the percentages of critical elements correctly
identified verbally and correctly discriminated visually
providing more information about subject performance.
Figure 4. Multiple Baseline Graph, Subject One.

The data for subject one (S-1) are found in Figures 4 and 5, and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-1 consistently recalled critical elements at a 100% rate. After intervention, S-1 showed significantly improved ability to visually discriminate critical elements from videotape performances. A summary of intervention performance shows that S-1 discriminated critical elements
correct as follows: 2/5 five times, 3/5 three times, 4/5 eleven times, and 5/5 fifteen times. Thus, in 26 of 34 videotaped classes, S-1 was able to discriminate 4/5 or 5/5 critical elements correctly. In only five cases were 2/5 elements correctly discriminated. S-1's performance in a live generalization test was as good as the intervention performances. Therefore, the intervention did significantly improve S-1's verbal identification and visual discrimination skills and these skills did generalize.
Figure 5. Bargraph, Subject One.
Figure 6. Multiple Baseline Graph, Subject Two.

The data for subject two (S-2) are found in Figures 6 and 7, and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-2 consistently recalled critical elements at a 100% rate. After intervention, S-2 showed significantly improved ability to visually discriminate critical elements from videotape performances. S-2 discriminated 4/5 ten times, and 5/5 eight times. Thus, in 18 of 34 videotaped cases S-2 scored 4/5
or 5/5 critical elements correct. In only four cases were fewer than 3/5 elements correctly discriminated. S-2's performance in a live generalization test was at least as good as the intervention performances. Thus, it is reasonable to conclude that the intervention did significantly improve S-2's verbal recall and visual discrimination skills and these skills did generalize.
Figure 7. Bargraph, Subject Two.
Figure 8. Multiple Baseline Graph, Subject Three.

The data for subject three (S-3) are found in Figures 8 and 9, and Tables 4, 5, 6 and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-3 consistently recalled critical elements at a 90% rate or better. After intervention, S-3 significantly improved ability to visually discriminate critical elements from videotape performances. S-3 discriminated 3/5 five times, 4/5 fourteen times, and 5/5 nine times. S-3 discriminated 4/5 or 5/5 critical elements correct in 23 of 34 videotaped subjects.
In only six cases were 2/5 or fewer elements correctly discriminated. S-3's performance in the live generalization test was as good as the intervention performance. Thus, the conclusion was made that the intervention did significantly improve S-3’s verbal recall and visual discrimination skills and these skills did generalize.
Figure 9. Bargraph, Subject Three.
The data for subject four (S-4) are found in Figures 10 and 11 and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. After intervention, S-4 consistently recalled critical elements at a higher rate over baseline efforts. Following intervention, S-4 showed significantly improved ability to visually discriminate critical elements from videotapes performances. S-4 discriminated 3/5 seventeen times, 4/5 seven times, and 5/5 three times. Thus, in 26 of 34 cases, S-4 was able to discriminate 3/4, 4/5, or 5/5
critical elements correct. In only eight cases were 2/5 or fewer elements correctly discriminated. S-4's performance in a live generalization test was equal to the intervention performances. Therefore, the intervention did significantly improve S-4's verbal recall and visual discrimination skills and these skills did generalize.
Figure 11  Bargraph, Subject Four.
Figure 12  Multiple Baseline Graph, Subject Five.

The data for subject five (S-5) are found in Figures 12 and 13 and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-5 consistently recalled critical elements at a 100% rate. After intervention, S-5 showed significantly improved ability to visually discriminate critical elements from videotaped performances. S-5 discriminated 3/5 eleven times, 4/5 seven times, and 5/5 thirteen times. Thus, in 20 of 34 videotaped performances, S-5 scored 4/5 or 5/5 critical elements
correct. In only three cases were 2/5 or fewer critical elements correctly discriminated. S-5's performance in the live generalization test was comparable to the intervention performances. Therefore, it is logical to conclude that the intervention did significantly improve S-5's verbal recall and visual discrimination skills and these skills did generalize.
Figure 13 Bar graph, Subject Five.
Figure 14. Multiple Baseline Graph, Subject Six.

The data for subject six (S-6) are found in Figures 14 and 15, and Tables 4, 5, 6 and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-6 consistently recalled critical elements between rates of 90% to 100%. After intervention, S-6 demonstrated significantly improved ability to visually discriminate critical elements from videotape performances. S-6 discriminated 3/5 thirteen times, 4/5 ten times, and 5/5 five times. Thus, in 28 of 34 videotapes cases, S-6 scored 3/5, 4/5 or 5/5
critical elements correct. In only six cases were 2/5 or fewer critical elements discriminated. S-6's performance in the live generalization test closely approximates the intervention performances. Thus, the intervention did significantly improve S-6's verbal recall and visual discrimination skills and these skills did generalize.
Figure 15 Bargraph, Subject Six.
Figure 16  Multiple Baseline Graph, Subject Seven.

The data for subject seven (S-7) are found in Figures 16 and 17 and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-6 consistently recalled critical elements between rates of 78% and 98% correct. After intervention, S-6 showed significantly improved ability to visually discriminate critical elements from videotape performances. S-7 discriminated 3/5 nine times, 4/5 eight times, and 5/5 seven times. Thus, in 18 of 24 videotapes cases, S-7 discriminated 3/5, 4/5 or 5/5
critical elements correct. In ten cases, S-7 scored 2/5 or fewer elements correctly identified. S-7's performance in the live generalization test was at least as good as the intervention performances. Therefore, it is reasonable to conclude that the intervention did significantly improve S-7's verbal recall and visual discrimination skills and these skills were successfully generalized.
Figure 17. Bargraph, Subject Seven.
Figure 18. Multiple Baseline Graph, Subject Eight.

The data for subject eight (S-8) are found in Figures 18 and 19, and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable with the exception of throwing and batting where baseline scores are stable, but higher than usual. Following intervention, S-8 consistently recalled critical elements at a 100% rate. After intervention, S-8 showed significantly improved ability to visually discriminate critical elements from videotaped performances. S-8
discriminated 3/5 eleven times, 4/5 ten times, and 5/5 ten times. S-8 discriminated 4/5 or 5/5 critical elements correct in 20 of 34 videotaped performances. In only four cases were fewer than 3/5 elements correctly discriminated. S-8's performance in the generalization test was better than the intervention performances. As a result, the conclusion is made that the intervention did significantly improve S-8's verbal recall and visual discrimination skills and these skills did generalize.
Figure 19. Bargraph, Subject Eight.
The data for subject nine (S-9) are found in Figures 20 and 21, and Tables 4, 5, 6, and 7. Baseline scores for verbal identification and visual analysis of critical elements are low and stable. Following intervention, S-9 showed substantial improvement in recall of critical elements over baseline scores in percent of critical elements identified correct. After intervention, S-9 showed significantly improved ability to visually discriminate critical elements from videotaped performances. S-9 discriminated 3/5 sixteen times, 4/5 three times, and 5/5 five times. Thus,
in 24 of 34 videotaped cases, S-9 discriminated 3/5, 4/5, or 5/5 critical elements correct. In ten cases, S-9 discriminated 2/5 or fewer critical elements correct. S-9's performance in the live generalization test was good as the intervention performances. It is therefore reasonable to conclude that the intervention did significantly improve S-9's verbal recall and visual discrimination skills and these skills did generalize.
Figure 21 Bar graph, Subject Nine.
Table 4
Mean Number of Critical Elements
Correctly Identified Verbally

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Table 5

Mean Number of Critical Elements
Correctly Discriminated Visually

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Table 7
Percent of Critical Elements Correctly
Discriminated Visually

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Analysis Of Data As It Relates
To the Research Questions

This section answers the research questions which are listed in Chapter I. Each question is presented and followed by an analysis of the pertinent data.

Research Question #1: How do subjects analyze sport skills verbally, under baseline conditions, prior to intervention?

Probes and baselines in this study were characterized by low stable data for verbal analysis. Each subject had to list in writing what he/she considered the five most important critical elements to be for each of the four different skills. Typically, the critical elements listed by subjects were often quite general and too vague to be identifiable as critical elements. In some cases, subjects were unable to list five critical elements. Frustration was expressed by some subjects who had difficulty verbally expressing (listing in writing) what they had just visually observed. It was not uncommon for some subjects to move their own arms and/or legs in an effort to simulate what they had just observed in an effort to translate actions into words.

The following examples are listed to illustrate the vague quality of subject generated critical elements.
Jumping (Subject #8)

1. push off back leg
2. lift front leg
3. extension of leg split
4. use of arms for extension
5. directing jump upward achieving height

Jumping (Subject #2)

1. beginning stance
2. arm swing
3. knee flex
4. forward/upward body motion
5. landing

Throwing (Subject #1)

1. follow through
2. shoulder rotation
3. push off back foot
4. move front leg forward
5. keep head up/look at target

Throwing (Subject #2)

1. foot position
2. arm swing
3. follow through
4. grip
5. (no response)

Batting (Subject #5)

1. keep elbows up
2. swing level
3. feet apart
4. weight on back foot to start
5. shift weight to front foot to finish

Batting (Subject #2)

1. stance
2. hand position on bat
3. follow through
4. arm swing
5. shoulder position
Cartwheel (Subject #4)
1. left arm down/flexed at elbow slightly
2. push off right leg
3. weight distributed on hands
4. head location/upper body
5. landing/balanced, parallel

Cartwheel (Subject #9)
1. arms extended awaiting weight
2. lower back stiff
3. keeping and kicking legs straight up in the air
4. using hips to pull legs on around
5. push off with hands to get power

The nonspecific nature of the critical elements listed in baseline, along with the wide range of responses and their questionable interpretation, clearly point to the difficulty subjects had in this study in verbally identifying what they considered to be the most important performance points or critical elements of a sport skill during baseline testing. In short, the accuracy of subject responses in comparison to critical elements generated by expert analyzers of sport skills can be described as extremely poor.

Research Question #2: How do subjects analyze sport skills visually, under baseline conditions, prior to intervention training?

Probes and baselines in this study were generally low and stable for correct visual discrimination of critical elements identified in sport skills. Thus, the ability to
discriminate critical elements appears not to have been in the repertoire of these subjects. If a critical element could not be properly identified and listed in writing, then no decision could be made regarding whether it constituted a correct response and was therefore scored as incorrect. This accounts for the fact that the data triangles (Δ) indicating correct visual discrimination are always even with or below the data dots (•) indicating correct verbal identification of critical elements. Clearly, this kind of performance in baseline yields evidence to support the position that, "you can't visually discriminate what you can't verbally identify" (Siedentop, 1984). In other words, one must know exactly what to look for to discriminate a critical element as correct or incorrect. (Hoffman, 1977c) reports similar findings when he invited sixteen veteran physical education teachers to diagnose a junior high school student throwing a ball while stepping with the ipsilateral foot. Only two of the sixteen teachers were able to correctly identify the student's problem.

The ability to correctly analyze or diagnose what took place in sport performance is obviously an important and complex visual process.

Baseline data indicate that subjects did not know what to look for in any of the videotaped performances of the four sport skills utilized in this study. As a result,
subjects were simply unable to make many correct visual discrimination decisions of critical elements performed correct or incorrect.

Research Question #3: Can subjects consistently recall five different critical elements for each of four different sport skills after viewing intervention training tapes?

The multiple baseline graphs and bargraphs show that subjects did recall the five critical elements immediately following introduction of each intervention and maintained the recall of critical elements during intervention and generalization. Subjects 1, 2, 3 and 8 achieved perfect recall of five different elements for four different sport skills throughout the study. Subjects 3, 4, 6 and 7 consistently scored five's and four's throughout the study. Subject 9 scored five's, four's and three's.

Of particularly importance to this aspect of the study is the fact that no induction effects can be observed in any of the multiple baseline graphs for verbal data generated by any one of the nine subjects. Cooper (1981) points out that induction takes place when the intervention is applied to one behavior and not only is the original behavior affected, but untreated baselines are also affected. Information about the controlling effects of the intervention is then lost. Because induction did not take place in
any of the verbal identification of critical elements data, it is reasonable to conclude with certainty that each of the twenty critical elements in this study are highly specific to its own skill and not generalizable to any of the other skills in this research.

Research Question #4: Can subjects discriminate the difference between correct and incorrect critical elements of student performance after intervention training?

Although the improvements are not as dramatic as the verbal recall data, the visual discrimination data for each subject are typically above baseline data with minimum overlap. Again, the multiple baseline graphs and bargraphs provide the proof. Subjects were able to discriminate the difference between correct and incorrect critical elements following intervention training at significantly higher levels of success over baseline testing. In most cases, this more effective discrimination of critical elements was maintained through intervention and generalization.

Of further interest, in this part of the study is the fact that no induction effects can be observed in any of the multiple baseline graphs for visual data generated by any of the nine subjects. Because induction did not take place, it is reasonable to conclude that the actual body
movements comprising each of the twenty critical elements is distinctly different (i.e., highly specific). Therefore, body movements (critical elements) do not appear to be helpful to subjects when analyzing skills other than the skill for which the movement was originally intended. This finding supports the position that sport skills are different and possess unique performance characteristics.

Research Question #5: What is the relationship between the ability to verbally identify the critical elements of a sport skill and the ability to visually discriminate critical elements as correct or incorrect?

In order to determine if a relationship existed between the variables of verbal recall and visual discrimination, a Pearson-Product-moment correlation coefficient was calculated. The r was computed by comparing each subject's verbal recall score (total number of correctly recalled critical elements throughout the study) with the corresponding visual discrimination score (total number of critical elements correctly identified as correct or incorrect). Table 8 lists the two variables and the respective subject scores. The correlation between the nine verbal recall scores and the nine visual discrimination scores produced an r of .86 at the .003 level of significance. This high
Table 8

Total Number of Critical Elements Correctly Discriminated Visually and Correctly Identified Verbally Across Baseline Intervention and Generalization Per Subject

<table>
<thead>
<tr>
<th>Subject</th>
<th>Total Visual Score</th>
<th>Total Verbal Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>234</td>
<td>285</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>279</td>
</tr>
<tr>
<td>3</td>
<td>211</td>
<td>264</td>
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<tr>
<td>4</td>
<td>181</td>
<td>216</td>
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<tr>
<td>5</td>
<td>189</td>
<td>276</td>
</tr>
<tr>
<td>7</td>
<td>192</td>
<td>250</td>
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<tr>
<td>8</td>
<td>226</td>
<td>297</td>
</tr>
<tr>
<td>9</td>
<td>163</td>
<td>207</td>
</tr>
</tbody>
</table>

*Scores represent elements identified correct out of a total of 360 critical elements for visual discrimination, and verbal identification.
positive correlation is visually depicted in the computer-generated scatterplot in Figure 22.

Research Question #6: Can sport skill analysis proficiency acquired through individualized videotape instruction be successfully generalized in school settings?

The training tapes developed for this study were designed on a pedagogical format with the distinct purpose of helping future teachers and coaches become more effective analyzers of sport skills as they work in schools and on playing fields. Therefore, the subject's ability to transfer or generalize what was learned during intervention, in the laboratory, to a real school setting with live students was a crucial part of this study.

Visual analysis of the multiple baseline graphs, bar-graphs, and examination of Tables 4, 5, 6, 7 and 8 provide clear evidence that the verbal recall skills and visual discrimination skills acquired in intervention did generalize to the analysis of live students in a real school setting. Thus, it is reasonable to conclude that analytical skills trained via videotape programs do generalize to school settings with live students.
Figure 22. Scatterplot for Correlation of Verbal and Visual Scores.
Research Question #7: Which critical elements, skill or skills do subjects find most difficult to analyze in this study?

The responses of each subject were tabulated and totaled as correct/incorrect for visual discrimination for each critical element for each student viewed on the test tape during intervention (see Table 9). Each column of five critical elements represents one student on tape. For example, seven subjects were able to properly discriminate the first element in jumping as being properly executed by student number one, while two subjects failed to make the correct discrimination. This tabulation of correct/incorrect elements was conducted to help locate students on test tape that subjects had difficulty analyzing, or more specifically, a critical element or elements executed by individual students that subjects had difficulty visually discriminating as correct/incorrect.

The circled numbers on the chart call attention to tabulations such as 5/4 or 4/5 showing divided subject ability to discriminate a critical element as correct or incorrect. This chart also shows tabulations such as 1/8 or 2/7 indicating that the majority of the subjects were unable to make the proper discrimination. Clusters of circles show sensitive areas on the tape that may need revision. Finally, this chart helps locate students
Table 9

Total Number of Critical Elements Correctly/Incorrectly
Visually Discriminated During Intervention Testing

<table>
<thead>
<tr>
<th>Skill</th>
<th>Critical Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jump</td>
<td>7/2 2/7 6/4 4/5 6/3 8/1 8/1 7/2</td>
</tr>
<tr>
<td>1</td>
<td>8/1 9/0 8/1 6/3 9/0 8/1 7/2 8/1</td>
</tr>
<tr>
<td>2</td>
<td>8/1 8/1 5/4 6/3 7/2 7/2 2/7 6/3</td>
</tr>
<tr>
<td>3</td>
<td>2/3 9/0 8/1 7/2 9/0 8/1 5/4 8/1</td>
</tr>
<tr>
<td>4</td>
<td>6/3 8/1 7/2 6/3 7/2 8/1 6/3 7/2</td>
</tr>
<tr>
<td>5</td>
<td>8/1 8/1 7/2 6/3 7/2 8/1 6/3 7/2</td>
</tr>
<tr>
<td>Throw</td>
<td>8/1 8/1 9/0 8/1 8/1 2/7 7/2 7/2</td>
</tr>
<tr>
<td>1</td>
<td>8/1 8/1 8/1 9/0 8/1 9/0 8/1 9/0</td>
</tr>
<tr>
<td>2</td>
<td>8/1 7/2 8/1 6/3 8/1 7/2 7/2 7/2</td>
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<tr>
<td>3</td>
<td>8/1 7/2 7/2 7/2 7/2 8/1 3/6 8/1</td>
</tr>
<tr>
<td>4</td>
<td>2/3 9/0 8/1 6/3 6/3 8/1 8/1 8/1</td>
</tr>
<tr>
<td>5</td>
<td>7/2 8/1 7/2 8/1 6/3 7/2 5/4 6/3</td>
</tr>
<tr>
<td>Eat</td>
<td>5/4 4/5 6/3 7/2 5/4 6/3 5/4 6/3</td>
</tr>
<tr>
<td>1</td>
<td>2/7 9/0 9/0 6/3 5/4 9/0 6/3 7/2</td>
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<td>2</td>
<td>3/6 9/0 9/0 9/0 8/1 9/0 8/1 8/1</td>
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<td>9/0 9/0 9/0 9/0 8/1 9/0 8/1 8/1</td>
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<tr>
<td>4</td>
<td>9/0 9/0 9/0 8/1 9/0 9/0 8/1 8/1</td>
</tr>
<tr>
<td>5</td>
<td>8/1 9/0 9/0 9/0 8/1 9/0 9/0 8/1</td>
</tr>
</tbody>
</table>
performing on the test tape that may simply be too difficult to analyze such as student four and student seven in jumping.

The most difficult skill to analyze appears to be batting, having sixteen out of forty elements circled as difficult discrimination decisions. Critical element number 4 for batting (full swing with straight arms) proved to be the most difficult element to analyze visually. As might well be expected, sport skills and related critical elements that feature high speed movement, such as the arm swing in batting, will be difficult to analyze via the naked eye and will undoubtedly pose formidable obstacles in qualitative sport skill analysis.

Research Question #8: Are subjects, as consumers of individualized videotape instruction in sport skill analysis, satisfied with the procedures and results?

A number of behavior analysts are now verifying their objective data collection with systematic subjective measures of consumer satisfaction (Wolf, 1978). Thus, behavior analysts have become more concerned with the "social validity" of their work. The three dimensions of social validity include assertion of meeting the program objectives, determining the social appropriateness (with regard to cost, practicality, and ethics), and social importance
which is a consumer evaluation of program helpfulness (Wolf, 1978). Research question #8 addresses the third dimension of social validity where the subject (i.e., consumer of the program) evaluates the program.

One week following generalization testing, each subject attended a private follow-up evaluation meeting and answered eight key questions which focus on the third dimension of social validity (see Appendix I). Subject responses to each question were audio recorded. What follows is a brief synopsis of subject feedback with regard to their satisfaction as users of this personalized system of videotape instruction for sport skill analysis.

Overall, subjects expressed a high degree of satisfaction with the system as a means of learning to analyze sport skills. This satisfaction is expressed in the following sample feedback statements:

Subject #1 - "It seemed to be a really good system overall."

Subject #3 - "I rate the system very highly."

Subject #5 - "I like it. I learned a lot. I was told what to look for and saw it applied. The more you see visually, the better you learn."

All subjects found the four instructional tapes to be well devised. Most would have preferred to observe five instant replays of each student on the test tape as compared to three. Also, each subject agreed that five critical
elements for each skill was not too difficult to remember and probably represented the best number of critical elements for each skill.

Each subject, in his or her own way, described a feeling of being lost in their attempts to analyze skills under baseline conditions prior to intervention. Typical comments include:

"I didn't know what to look for."

"It was tough. I had to decide for myself what the critical elements were."

"I felt lost and just thought of what I could."

Following intervention, subject agreed that they were more confident in their ability to analyze sport skills. Comments include:

"I felt more confident about being able to see what the student was doing right or wrong."

"I could look at it more intensely and spot performance points a lot better."

"I knew what I was looking for; it made it a lot easier."

At the close of each evaluation session, each subject was given the opportunity to make any additional comments about his/her participation in the study. The social validity of this research project is nicely summed up by two different subjects in the following quote.
"I wish we could do more different skills. I was able to use the critical elements in some of my other classes. I wish we had a class of just identifying critical elements."

"I enjoyed it very much. I have learned a lot from it...how I analyze movement. I learned how important it is to carefully analyze a skill and pick it apart."

**Discussion**

The purpose of this study was to determine whether undergraduate physical education majors could improve their ability to analyze middle school students performing select sport skills as a result of individualized videotape instruction. Of particular interest was the effect this instructional strategy would have on a subject's ability to verbally identify the critical elements of a sport skill and visually discriminate those elements as correct or incorrect when viewing selected middle school students. The graphic analysis of multiple baseline data for each subject showed quite clearly that the instructional videotapes were effective in helping subjects identify the critical elements of a sport skill as well as improve ability to visually discriminate those elements as correct or incorrect.

The experimental strength of this study lies in its replication across nine different subjects. Similar results replicated among the subjects in baseline, intervention, and generalization leave no question that the results are
reliable in the truest experimental sense.

Of further interest is the fact that the four instructional videotape interventions presented as a personalized system of instruction, produced not only an experimentally significant difference between baseline and intervention/generalization phases of the study, but more importantly a clinically significant change was produced in each of the subjects as well. Clinical significance refers to a comparison between an achieved behavior change and the level of change required for a client to function effectively within society (Risley, 1970). The change required to achieve clinical significance is therefore usually greater than the change required to produce a statistically significant difference in single subject research.

As an ideal, applied interventions strive for changes that ordinarily surpass statistical significance. Yet, for clinical evaluation, statistical significance is an ancillary and, to many individuals, irrelevant criterion. The concern with clinical rather than statistical significance has led investigators to focus upon independent variables that frequently produce dramatic change (Hersen & Barlow, 1978, p. 267).

The infinitesimal number of research studies on sport skill analysis provide no criteria for what constitutes an acceptable level of proficiency in analyzing skills while teaching and coaching. Only an assumed axiom exists which states that those individuals recognized as successful
teachers and coaches must be better at skill analysis than their peers. This researcher is suggesting that future teachers and coaches that can recall five critical elements of a sport skill 90% to 100% of the time and correctly discriminate those elements as correct or incorrect 70% or more of the time, are operating at a clinically or socially significant level of a very difficult task. Unless objectives, performance criteria, and training programs are established on sound pedagogical basis, skill analysis will remain on the menu of things that get done more by chance than by design.
CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS,
AND RECOMMENDATIONS

Chapter V includes a summary of the study, a listing of the findings based on the analysis of the data, conclusions, and recommendations for continued study.

Summary

A review of the literature reveals that few studies have been conducted which examine how teachers and coaches analyze sport skills. The review also indicates that even fewer models or systematic observation systems exist for the analysis of sport skills and most of them have never been empirically tested. The purpose of this study was to determine whether undergraduate physical education majors could improve their ability to analyze middle school students performing select sport skills as a result of individualized videotape instruction. Of particular interest was the effect this instructional strategy would have on a subject's ability to verbally identify the critical elements of a sport skill and visually discriminate those elements as correct, incorrect or missing when viewing selected middle school students.

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Nine undergraduate physical education majors at The Ohio State University volunteered to participate in this study. A single subject, multiple baseline research design was utilized to test each subject's ability to analyze four sport skills including the standing long jump, overarm throw, batting, and cartwheels. Subjects viewed authentic student skill performance on a test videotape. The baseline phase allowed for measurement of subject ability to identify critical elements and discriminate those elements as correct or incorrect prior to introduction of the intervention training videotapes. The intervention phase allowed for measurement of subject ability to analyze skills following the viewing of the instructional training videotapes. The generalization phase of the study allowed for testing each subject's ability to transfer what was learned in the laboratory setting to analyze authentic student performances in a real school setting. The study was conducted in six sessions in a two week period.

Findings

The data collected and analyzed in this study furnish the following findings:

1. The ability to identify verbally critical elements of sport skill was very poor across all subjects in this study under baseline conditions. Subjects generally identified
one or two elements correct out of five.

2. The ability to visually discriminate critical elements as correct or incorrect was very poor across all subjects under baseline conditions. Subjects were generally able to correctly discriminate one or two elements out of five.

3. Subjects significantly improved their verbal recall of critical elements for each of the four different sport skills after viewing intervention training videotapes.

4. Subjects did visually discriminate the difference between correct and incorrect critical elements at a significantly higher level of proficiency over original baseline efforts after viewing the intervention training videotapes.

5. A direct positive linear relationship \((r = .86)\) was measured between the ability to verbally identify the critical elements of a sport skill and the ability to visually discriminate critical elements as correct or incorrect.

6. Sport skill analysis proficiency acquired through individualized videotape instruction was successfully generalized to authentic student execution of skills in a real school setting.

7. The most difficult skill to analyze in this study was batting due primarily to the difficulty subjects encountered when visually discriminating critical element number four (full serving with straight arms) as correct
or incorrect.

8. The subjects of this study, as consumers of individualized videotape instruction in sport skill analysis, were satisfied with the procedures and results.

Conclusions

1. The analysis of graphed multiple baseline data for each subject showed clearly that the test videotape and instructional videotapes, utilized in a personalized system of instruction, were very effective in helping subjects verbally identify the critical elements of sport skills as well as improve ability to visually discriminate those elements as correct or incorrect in intervention and generalization.

2. A positive linear relationship exists between verbal identification of critical elements and visual discrimination of critical elements as correct or incorrect. In short, as verbal recall scores improved, so did visual discrimination scores. It would appear that the ability to recall critical elements acts as a cue to focus attention to those features of a sport skill performance that require discrimination.

3. This study and others call attention to the importance of qualitative sport skill analysis and the dismal level of preparation undergraduate physical education programs provide future teachers and coaches. This study
represents a strong case for the support of qualitative sport skill analysis pursued under the pedagogical domain for the preparation of future teachers and coaches.

**Recommendations**

Based on a review of the study and the findings, the following recommendations are suggested:

1. Subjects should be contacted and further research should be conducted to measure subject verbal recall of critical elements and visual discrimination ability as a follow-up study.

2. This study should be faithfully replicated with a different arrangement of the generalization phase. The original order of four jumpers, four throwers, four batters, and four cartwheels should be broken so that skills being observed appear in true random order creating a more stringent test of generalization.

3. This study should be conducted with different subject populations including subjects that are well experienced in teaching, well experienced in coaching, and subjects that have very little knowledge of, or experience in, sport. A comparison of the results of different subject populations could then be conducted.

4. Further research is needed utilizing different closed sport skills and critical elements.
5. The feasibility of using the testing videotape and the instructional videotapes with groups of students should be researched. A pretest-posttest control group design (Campbell & Stanley, 1963) is recommended with the experimental group viewing the test and instructional videotapes on one large viewing screen.

6. The methods of skill analysis training utilized in this research project should be compared with other methods of preparing teachers to analyze sport skills.
Informed Consent Form

To the Student:

I hope you will participate as a subject in a project I am about to undertake for my doctoral dissertation. This project will be conducted under the supervision of Dr. Daryl Siedentop at The Ohio State University. The following paragraph will briefly describe the goal of this project and what would be expected from you if you decide to participate.

Over a two week period I will collect information on the way undergraduate physical education majors analyze sport skills. You will be asked to attend a private testing session three days a week. Sessions will last from thirty to sixty minutes, and you will be asked to view brief instructional video tapes and analyze sport skills on video tape. The last session will be held in a public school; transportation will be provided.

Your participation in this study should benefit your personal development and growth as a professional. It is also hoped that this project will result in improvements in the preparation of physical education teachers.

You are assured that your identity will not be revealed in publications, documents and/or presentations, and that all information about you will be kept strictly confidential. Any further questions you may have regarding the participation will be answered. Furthermore, you have the right to resign as a participant of this project at any time. If you do not have any questions, and if you are willing to participate in this study, please sign your name on the line below.

NAME: ___________________________
PSI STUDY SHEET 1  Standing Long Jump

This study sheet will help clarify the program you just observed. Please review the five critical elements for the standing long jump.

1. **DEEP CROUCH**  Look for flexion at the knees to be 90 degrees or less. A 90 degree angle or an angle less than 90 degrees should also be shown between the upper body and the thighs.

   ![Correct position](image1.png)  ![Correct position](image2.png)  ![Incorrect position](image3.png)

2. **ARMS BEHIND BACK**  You should be able to see daylight between the arms and the top of the back all the way to the shoulders.

   ![Correct position](image4.png)  ![Correct position](image5.png)  ![Incorrect position](image6.png)

3. **FULL BODY EXTENSION AT A 45 DEGREE ANGLE**  The arms, trunk, and legs should form a straight line just after the toes leave the floor. The body angle should be 45 degrees.

   ![Correct position](image7.png)  ![Incorrect position](image8.png)

4. **WELL DEFINED HIP FLEXION**  The angle between the upper body and the thighs should be 90 degrees or less. The center of gravity should be well behind the feet.

   ![Correct position](image9.png)  ![Correct position](image10.png)  ![Incorrect position](image11.png)

5. **DEEP CROUCH LANDING WITH ARMS IN FRONT OF BODY**  The student should land in a squat position with the chest touching or almost touching the knees. The arms should be held in front of the body.

   ![Correct position](image12.png)
PSI STUDY SHEET 2 Overarm Throw

This study sheet will help clarify the program you just observed. Please review the five critical elements for the overarm throw.

1. **STEP WITH OPPOSITION** The student should step forward into the throw with the foot on the opposite side of the body of the throwing arm. For example, if the throw is made with the right arm, the student should step into the throw with the left foot. A throw that is made with the feet side by side without a step is incorrect. Also, watch for students that step into the throw with the foot on the same side of the body as the throwing arm (this is incorrect).

2. **OPEN UP** As a step with opposition is taken, or just before a step with opposition is taken, the thrower should turn toward you giving you a frontal plane view of his/her body. The thrower's head should be turned toward the target, and the arms will be fully or partially extended out to the sides.

3. **FULL FORWARD ROTATION OF THE BODY** The thrower should turn from a frontal plane view, in opening up, to a side profile view rotating at least 90 degrees.

4. **ELBOW LEADS WITH FOREARM EXTENSION** The arm will be swung backward in preparation for the throw. The elbow will then lead the throw moving horizontally as the forearm unfolds toward the target.

5. **WEIGHT TRANSFER FROM BACK FOOT TO FRONT FOOT** The momentum of the throw should carry the thrower's body weight forward from the back foot to the front foot.
PS1 STUDY SHEET 3  Batting

This study sheet will help clarify the program you just observed. Please review the five critical elements for batting.

1. BAT COCKED BEHIND HEAD OR SHOULDER  The bat should be cocked behind the head or shoulder for maximum swing. Watch carefully as some students will assume a ready position with the bat cocked behind the head or shoulder while some students will not cock the bat behind the head or shoulder until they initiate the swing; either way is fine. Of course, some students never cock the bat.

2. STEP INTO THE SWING  The student should step forward into the swing with the lead foot. The length of the step will vary, but you should see the foot move forward on the floor and not just pivot on the heel.

3. FULL FORWARD BODY ROTATION  The batter should rotate a minimum of 90 degrees from the frontal plane view (side stand with bat cocked) to a side profile view after striking the ball.

4. FULL SWING WITH STRAIGHT ARMS  The bat should be swung from behind the head or shoulder and should travel through an arc of 180 degrees before contacting the ball. The arms should be fairly straight or extended as the bat contacts the ball.

5. SWING IS BASICALLY HORIZONTAL  Look for a swing that is basically level through a horizontal plane. Some students will swing up too much on the ball while others will swing down.

    correct  incorrect  incorrect
PSI STUDY SHEET 4  Cartwheel

This study sheet will help clarify the program you just observed. Please review the five critical elements for the cartwheel.

1. **LEAD FOOT ESTABLISHED** The student may start the cartwheel from a side stand position or from a forward facing position. In either case the student should establish a lead foot. This means starting the cartwheel by stepping forward on one foot.

   ![Diagram of lead foot]

2. **LUNGE** The lunge should be made by flexing the lead leg to lower the upper body to the mat. Even if a lead foot is not established, one leg should be flexed at the knee to lunge.

   ![Diagram of lunge]

3. **HAND, HAND, FOOT, FOOT PATTERN** Watch for a hand, hand, foot, foot movement pattern with the hands and feet contacting the mat much like the spokes of a wheel...1, 2, 3, 4. The arms and legs should be straight.

   ![Diagram of hand, hand, foot, foot pattern]

4. **BODY EXTENDED THROUGH VERTICAL PLANE** The hips should pass over the hands in a true handstand position with the arms and legs forming an X. The body should move through a vertical plane. The arms and legs should be straight.

   ![Diagram of body extended through vertical plane]

5. **FINISH IN BALANCED SIDE STAND** The student should finish the cartwheel in a side stand showing you either the front or back of the body, not a side profile. The student should be able to maintain his/her balance in this position.

   ![Diagram of finish in balanced side stand]
<table>
<thead>
<tr>
<th>Critical Elements</th>
<th>Verification</th>
<th>Credit Yes No</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Deep Crouch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Arms Behind</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Full Body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension at</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 Degree Angle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Hip Flexion</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Crouch Landing With Arms in Front</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Elements</td>
<td>Verification</td>
<td>Credit</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>(1) Step With Opposition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Open Up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Full Forward Rotation of The Body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Elbow Leads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Weight Transfer From Back Foot to Front Foot</td>
<td></td>
<td></td>
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</table>

Comments:
<table>
<thead>
<tr>
<th>Critical Elements</th>
<th>Verification</th>
<th>Credit</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Bat Cocked</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behind Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or Shoulder</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(2) Step Into</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Swing</td>
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<td></td>
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<tr>
<td>(3) Full Forward</td>
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<tr>
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<tr>
<td>(4) Full Swing</td>
<td></td>
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<tr>
<td>With Straight</td>
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<tr>
<td>Arms</td>
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<tr>
<td>(5) Swing is</td>
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<tr>
<td>Basically</td>
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<tr>
<td>Horizontal</td>
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Comments:
<table>
<thead>
<tr>
<th>Critical Elements</th>
<th>Verification</th>
<th>Credit</th>
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<tbody>
<tr>
<td>(1) Lead Foot</td>
<td>Established</td>
<td></td>
</tr>
<tr>
<td>(2) Lunge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Hand, Hand,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot, Foot Pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Body Extended</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot, Foot Pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Finish in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balanced Side Stand</td>
<td></td>
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</tbody>
</table>

Comments:
Standing Long Jump Script
Hi! My name is Mike Kniffin and today we are going to take a look at the standing long jump. This is a very common fundamental motor skill in physical education, but how well can you analyze it? Your effectiveness as a teacher or coach depends in large part on your ability to analyze skills accurately and provide appropriate feedback. As a result of today's lesson you should be able to identify the critical elements of the standing long jump and the most common performance errors.
Let's start by taking a look at the way the standing long jump should be performed.

This college student will demonstrate the mature and technically correct form of a well executed standing long jump.

Let's take a look at an instant replay of that jump.
Teachers and coaches need to cue in on the most important performance points or critical elements that comprise a successful standing long jump.

The jumper you just observed performed the following five critical elements.

1. Slow zoom to closeup of elements.
2. Each element listed one at a time with voice.
3. Deep crouch
4. Arms behind back
5. Full body extension at a 45 degree angle
6. Well defined hip flexion
7. Deep crouch landing with arms in front of body
Let's take a closer look now and see how these critical elements can be combined to form a well executed standing long jump.

Analyzing the standing long jump is not difficult if you can identify the critical elements. So let's start with the first critical element of the standing long jump which is a deep crouch. Notice the jumper's hips, knees, and ankles are well bent; the trunk is at a 45 degree angle or parallel to the floor.
The second critical element is arm swing well behind and above the back.

The third element is complete body extension at a 45 degree angle. Notice the arms, hips, knees and ankles nearly form a straight line and the angle of that line is 45 degrees.
The fourth element is well defined hip flexion or a piking action with the center of gravity well behind the feet as the jumper prepares to land.

The fifth and final critical element for the standing long jump is a deep crouch landing with arms in front of the body.
When these five critical elements are properly performed and combined they form a well executed standing long jump.

Remember, the critical elements for the standing long jump include:

1. Each element listed one at a time with no voice.
2.
3.
4.
5.
Observe this student jump again and say the critical elements out loud as they occur.

Now observe the jumper at normal speed and practice identifying the critical elements.
Your ability to recall the five critical elements and the model performer you have been observing will serve as a standard of performance which you can use to compare other jumping performances against. In short, this standard of performance will help you become a better analyzer of the students you teach and coach. Now let's take a look at some of the most common performance errors associated with the standing long jump.

These errors represent some of the most typical jumping problems you'll encounter among the students you will teach and coach. Much like a physician, your ability to analyze the problem, and prescribe appropriate treatment is important if your students are to learn and improve.
Our first subject is a sixth grade girl. Watch her jump.
Watch once again.

Use your standard of performance to analyze this jump. Notice the lack of a deep preparatory crouch for the first critical element. Note the lack of hip, knee, and ankle flexion. Thus, a shallow preparatory crouch is a common performance error.
Now look for the second critical element and notice it is missing. This student does not swing her arms up behind the back. Lack of sufficient arm swing is a violation of critical element number two and, therefore, a common performance error to watch for.

The third critical element is body extension at a 45 degree angle. This student does not produce full body extension nor achieve the 45 degree jumping angle. Her jump is up in more of a vertical plane than out in a horizontal plane. Failure to extend the body in flight at a 45 degree angle is another common jumping error to watch for.
Now observe that critical element number four is never really achieved. Instead of well defined hip flexion, with the center well behind the feet, this student is only able to produce a shallow hip flexion. This is another common error.

Finally, the fifth common error is seen in a lack of a deep crouch landing. This is a standing landing.
By now you should realize that many performance errors of the standing long jump are directly related to the student's inability to perform the critical elements of the jump at the desired level of proficiency. To review, the most common performance errors of the standing long jump include:

1. A shallow preparatory crouch
2. Lack of sufficient arm swing
3. Failure to extend the body and achieve a 45 degree angle
4. Shallow hip flexion
5. Standing landing

Each error listed one at a time with voice.
Now practice identifying the common errors by observing the jumper at normal speed.

Each element listed one at a time with no voice

1. Deep crouch
2. Arms behind back
3. Full body extension at a 45 degree angle
4. Well defined hip flexion
5. Deep crouch landing with arms in front of body

** THE END **
TEST TAPE VIEWING DIRECTIONS

You are about to observe a video tape of a number of different students performing various sport skills. These are actual performances taken from live school settings where students are performing skills as well as they know how. Each student you observe will be referred to as a subject and will be given a subject number. You will observe each subject perform a skill three times at normal speed. Upon completion of the third showing, you will be asked to analyze the performance you observed by identifying what you consider to be the five most important performance points or critical elements for that skill. Write your answers on the left side of your answer sheet opposite the numbers one through five. You may list these critical elements in any order you desire. If a critical element was performed correctly by the subject you viewed, please circle the "C" for Correct on the right side of the page opposite the element. If the critical element was performed incorrectly or was missing, please circle the "I" for Incorrect. Please note the following example:

Session #_________________ Name__________________________________________
Subject #_________________ Date ________________________________
Skill______________________

<table>
<thead>
<tr>
<th>Critical Elements</th>
<th>Correct</th>
<th>Incorrect/Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ball played opposite left heel.</td>
<td>C</td>
<td>I</td>
</tr>
<tr>
<td>2. Feet shoulder width apart in stance.</td>
<td>C</td>
<td>I</td>
</tr>
<tr>
<td>Critical Elements</td>
<td>Circle One</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>3. Turn back to target on backswing.</td>
<td>C  I</td>
<td></td>
</tr>
<tr>
<td>4. Keep knees flexed throughout the swing.</td>
<td>C  I</td>
<td></td>
</tr>
<tr>
<td>5. Contact the ball with full arm extension.</td>
<td>C  I</td>
<td></td>
</tr>
</tbody>
</table>

In summary, what you are asked to do for each subject viewed is:

(1) Identify what you believe to be the five (5) most important critical elements for that skill.

(2) Identify which of those 5 elements were performed correctly for that subject.

(3) Identify which of the 5 elements were performed incorrectly or not at all for that subject.

Please record your answers promptly after viewing the tape. The instructor will tell you when to stop. Please sign your name on the answer sheet and prepare to view the next subject.
<table>
<thead>
<tr>
<th>Critical Elements</th>
<th>Correct</th>
<th>Incorrect/Missing</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>C</td>
<td>I</td>
</tr>
<tr>
<td>2.</td>
<td>C</td>
<td>I</td>
</tr>
<tr>
<td>3.</td>
<td>C</td>
<td>I</td>
</tr>
<tr>
<td>4.</td>
<td>C</td>
<td>I</td>
</tr>
<tr>
<td>5.</td>
<td>C</td>
<td>I</td>
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</table>
INSTRUCTIONAL TAPE VIEWING

DIRECTIONS

You are about to see a ten-minute instructional video tape about a select sport skill: please watch and listen carefully. After viewing the tape, you will be given a one-page study guide to help clarify and review what was presented in the program. You may watch the video tape again in its entirety or you may watch any part or parts of the program you desire. Study the video tape and handout at your own pace. Let the instructor know as soon as you are finished. Please use the information you acquire by watching this tape as specifically as possible when analyzing student performance and filling out the answer sheets.
APPENDIX H
Figure 22. Arrangement of Equipment and Subjects for Generalization Testing.
APPENDIX I
Post Study Interview Questions

1. You viewed each subject on the test tape 3 times at normal speed (3 instant replays of each student). How difficult did this make the analysis?

2. Ideally, how many times would you like to view each performer on the test tape before making the analysis?

3. Please describe how you reacted as you analyzed skills being performed before viewing the instructional videotapes.

4. Please describe how you reacted as you analyzed skills after studying the instructional videotapes.

5. Was it difficult to recall the five critical elements for each skill?

6. Were five critical elements too many, too few, or just about right per skill?

7. Please think back to the format of the instructional videotapes and tell me if you have any suggested changes that would make learning more productive or enjoyable.

8. How helpful were the one-page PSI study guides?

9. Please describe how you reacted as you analyzed students in a live school setting under generalization testing conditions.

10. Overall, how would you rate this system as a means of learning to analyze skills?

11. Do you have any additional comments about your participation in this study?
LIST OF REFERENCES


