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A Study of the Effectiveness of Modern Digital Imaging Techniques with Middle School Physical Education Students during the Development and Acquisition of Motor Skills

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A STUDY OF THE EFFECTIVENESS OF MODERN DIGITAL IMAGING TECHNIQUES WITH MIDDLE SCHOOL PHYSICAL EDUCATION STUDENTS DURING THE DEVELOPMENT AND ACQUISITION OF MOTOR SKILLS

By

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ABSTRACT

As evidenced in the literature, innovations and enhancements in video technology have enabled educators in various content areas to provide an alternative, yet innovative means of presenting information and feedback to students. Research has also shown the effectiveness of video with professional athletes, college athletes, and higher skilled students. However, research dealing with the effectiveness of video feedback with lower skilled students in physical education is minimal. Knowing this, the current study examined the effectiveness of digital video feedback when used with students who were in the beginning or associative stages of learning. The study also examined if any learning differences existed between males and females when using video feedback and the role video feedback played in student motivation.

Participants were divided into three interventions (video, traditional, verbal) and were given the task of juggling a soccer ball as many times as they could with their feet. After five weeks, a post-test and a retention test were given to each intervention. Results showed that when digital video feedback was used with eighth grade physical education students in this particular context, no differences existed between the interventions for the post-test and retention test. Further results indicated that males and females reap similar benefits from using digital video feedback when used with the skill of soccer juggling. Qualitative results showed that when digital video feedback was used on a daily basis, it had the potential to negatively affect student motivation toward the skill being learned. Further insight and thoughts about the use and implementation of digital video feedback are discussed along with recommendations for future studies within this area.

CHAPTER 1
INTRODUCTION AND REVIEW OF LITERATURE

Introduction

As with other professionals in the field of education, physical education teachers must adapt, be innovative, and flexible to meet the standards and objectives set forth by our educational system. Essential qualities like these aid teachers, regardless of content area, in creating and fostering better, more positive learning environments. Although the basic physical skills, locomotor movements, and movement concepts taught in physical education classes remain fairly static in nature, the environment in which they are presented is dynamically and rapidly changing. Larger class sizes, limited space, and limited funds are a few factors affecting today's public school physical education teachers. Simply put, instructional methods and techniques that worked thirty years ago will not suffice for students in the present.

Through research and years of experience, physical educators and other educational professionals have adapted to students' needs by taking the time to recognize the value of understanding how their students learn cognitively (Corno & Snow, 1986; Gardner, 1983; Gregorc, 1985; Johnston, 1997; Ross, Drysdale, & Schulz, 1999; Sarasin, 1998; Sims & Sims, 1995) and physically (Darden & Shimon, 2000; Fitts & Posner, 1967). Awareness of different types of learning styles and physical stages enables teachers to modify their teaching and feedback to better suite the learning needs of their students. Along with understanding the various learning styles, teachers also have come to utilize the various elements of technology to enhance student learning.

Technology, in its broadest sense, includes everything from computers and the Internet to loop films and digital video discs (DVD). Inherently, physical education has not been known for its rapid acceptance and integration of technology into its curriculum. However, one area of technology that has the potential for increasing learning within physical education classes is the use of digital video. Some earlier forms of video technology such as loop films and slides have been used to illustrate various concepts and movements in physical education with some success.

Nevertheless, these pieces of video technology have many limitations. With current digital video technology, these limitations could be drastically minimized. When executing different motor skill activities, the use of current digital video could enable students to receive more immediate, individual, and private feedback as well as, give them a more active role in the learning process. Without frequent and correct feedback, the motor skills being executed by students may either be done incorrectly or learned improperly, thereby impeding the acquisition of the skill and the students' achievement. Although physical educators agree that feedback is vital to learning, the overwhelming student to teacher ratio in many physical education classes, in addition to time restraints, make it extremely difficult and even impossible at times to watch and give feedback to every single student more than once or twice during the class.

With conventional means, physical educators may see overcoming obstacles such as large classes and time restraints as an unattainable objective. However, using current video technology, students could perform, record, view, and compare their performance to the standard, thereby allowing them to receive immediate feedback. In addition to the immediate feedback, students could have the opportunity to critically analyze, problem solve, and adjust their next execution of the skill based upon the standard interpretation of mistakes. Unfortunately though, over the past several years, the art of promoting skills like critical thinking and problem solving within the various curricula has appeared to be less prevalent (Burbach, Matkin, & Fritz, 2004). Norris (1985) also adds that in every level of education, critical thinking is below what it should be. In light of this factor, there needs to be more focus and inclusion of higher order thinking in all facets of education. With this in mind, digital video could provide an avenue for increasing the opportunity students have to critically think and analyze.

In research dealing with various teaching styles in physical education, Mosston & Ashworth (1994) revealed the importance of promoting critical thinking and problem solving skills. They point out that in order for students to grow and expand academically, more responsibility needs to be given to the student for his/her own learning. This gradual shift in responsibility can be achieved through the modification of the teaching style being used, which could incorporate the use of digital video.

Utilizing digital video during the practice and execution of motor skills could provide an opportunity to foster higher order thinking and could also give students more responsibility for learning, which in turn has the potential to enhance motor skill performance. Given these factors along with the recent enhancements in video technology, physical educators could use digital video as a tool to aid in the learning of motor skills. Therefore, the purpose of this review of literature is to provide some insight on how the utilization of a tool such as current video technology may provide opportunities for physical education students to critically think and enhance their performance of motor skills.

Critical Thinking in Education

Like other learning skills, critical thinking is a vital and necessary component of education. In many instances though, critical thinking exists as nothing more than a lofty ideal. While many educational standards proclaim the value of critical thinking and promote its integration, the actual implementation and practice of critical thinking in the classroom appears to be minimal (Burbach, Matkin, & Fritz, 2004). Over the years, various factors such as improvements in technology and the ease with which information can be retrieved, have negatively affected the quality of work students produce in the classroom (Knowlton, 1997). While these improvements in and of themselves are not the cause for the decline in the quality of work, educators and students alike have allowed themselves to become dependent on these enhancements for the final solutions and answers rather than relying more on their critical thinking skills. As a result, the amount of careful thought they invest in their work is minimal. Since critical thinking has the potential to reach across the curriculum and empower students to probe and reflect on the problems and solutions formulated, the omission of this vital skill from any classroom environment may prevent students from reaching their full learning potential. In addition to this, the loss of critical thinking in education could promote the tendency to accept superficial solutions to problems or issues that deserve to be questioned or investigated further. With the additional demands of today's highly technological workforce coupled with the requirement to collaborate with others in various small and large group settings, the necessity for higher order thinking and critical thinking to be present in an individual's repertoire of skills should be encouraged. Therefore, with these factors in mind, critical thinking is a skill that should be cultivated throughout the educational careers of students.

Critical thinking, as described in the literature, possesses many characteristics that must be developed over time. Evaluating various perspectives of an issue (Browne & Keeley, 1998) and being able to identify problems and the assumptions surrounding the issue (Kennedy, Fisher, & Ennis, 1991) are but two of the many facets that compose the complex definition of critical thinking. Unlike lower order thinking, such as rote memorization and recall, where factual information is merely transferred and accepted, critical thinking requires the learner to weigh the facts and opinions from varying points of view, analyze what has been presented, formulate an assumption based on inferences and logic, and evaluate the validity and reliability of the final assumptions based upon the evidence collected (Kennedy, Fisher, & Ennis, 1991). Other research identifies critical thinking as having three interdependent traits. One trait, as suggested by Paul (1995), includes standards such as clarity, accuracy, relevance, and logic. When engaging in critical thinking, the second trait involves the application of these standards to promote better and more self-correcting thinking (Schwager & Labate, 1993). The final trait involves the integration of the previous traits as a daily part of the thinking process so that the manner in which an individual normally thinks is inseparable from his/her critical thinking (Paul, 1995).

Evidence in the literature suggests that the process for teaching critical thinking skills requires more time and preparation (Cleland & Pearse, 1995; Sparapani, 2000), but the benefits produced help learners gradually and more consistently attain positive, learning outcomes. One perspective emerging in the literature adopts the view that the emphasis for developing critical thinking skills should be on the process rather than merely on the outcome (Brookfield, 1987). By investing time into the process of critical thinking, educators can not only empower students to produce higher quality products, but will also provide the means for students to gradually shift their focus from merely receiving a grade to thinking deeper and analyzing more carefully the solutions and answers they offer. Pithers and Soden (2000) suggest that within a good critical thinking environment, students are active, wanting to ask questions, seek out information, and link what they find to the relevant question being discussed. In a study involving the integration of critical thinking into a middle school classroom, teachers found that students began to independently associate their initial knowledge of the subject matter with subject matter in other disciplines (Sparapani, 2000). Rather than processing information in isolated units, students tended to use their critical thinking skills across the curriculum and cognitively associate the information being presented to them. Further results from this study show that teachers reported higher levels of cooperation and motivation among students and that more time and thought went into their work and their answers. As a result, students produced higher quality products and responded with deeper thoughts about the issue being discussed (Sparapani, 2000).

Because of its versatility and cross-curricular adaptability, critical thinking lends itself well to other non-academic subjects such as physical education. Research has shown that critical thinking can be incorporated into the physical realm with positive results (McBride, 1989,1995; McBride, Schwager, Cleland, Rovengo, & Bandhauer, 1996). The reality of present-day physical education classes, as well as many classrooms, demonstrates the need for teachers to encourage more student-oriented thinking and relinquish more control of the decision-making and learning process to the student. Traditional means such as the demonstration/replication model is typically the method seen in physical education classes. Identifying the skill, breaking the skill down, demonstrating the skill, and allowing students to practice the skill promotes little or no higher order thinking on the students' part. With this method, the teacher makes all the decisions and choices. While this method is not wrong to utilize, consistent use over other methods of teaching can serve as a hindrance in helping students think and analyze things on their own. Ennis (1991) discovered in different elementary physical education classes the active, yet seamless, integration of critical thinking and the various movement education concepts. Teaching the students not only the proper technique to execute a skill, but teaching them to constantly question the direction, movement, spatial relationship, and other body awareness concepts re-enforces the skill of critical thinking. Allowing students to choose different pathways or levels of a movement or sport skill causes them to examine the options presented to them and then critically analyze the best way to execute the skill. Also in her study, Ennis (1991) noticed that the participating physical education teachers constantly directed their students' attention toward the movement itself and its characteristics. Doing this consistent re-focusing, students were able to determine the effectiveness of their movement and decide the best possible manner to solve a movement problem when given different situations.

Mosston and Ashworth (1994) explore and address the issue of promoting critical thinking and discuss how these skills can be cultivated in physical education classes through the variance of teaching styles and learning environments. Like critical thinking in other content areas, intellectual growth and learning must be achieved through the constant questioning and re-visiting of the topic at hand. Weighing opinions, seeing different means for solving the problem, and searching deeper into the issue are factors that help students develop their critical thinking skills in general education classes. Mosston and Ashworth (1994), rather than probing for solutions to verbal questions, offer that critical thinking can be developed and intellectual growth can be achieved through re-visiting and constantly thinking of not only how a sport skill or movement is done, but why it is done. Examining the movement or skill in various situations and under different circumstances allows the learner, if the teacher relinquishes some control to the student, to consider new or different ways to execute the skill. Consistently placing students in different scenarios and causing the student to re-examine the way a skill should be performed initiates a process referred to as cognitive dissonance (Mosston & Ashworth, 1994). Cognitive dissonance serves as a stepping-stone in learning critical thinking skills. If no stimulus is given that causes a question to be raised or an uncertainty in the movement's execution, then the learning process would be simply reduced to the demonstration/replication model. In the latter half of their spectrum of teaching styles, Mosston and Ashworth (1994) point out that cognitive dissonance is a must if critical thinking is to occur. For example, the sport skill of dribbling a soccer ball would be very simple to execute with no one else around or with any objects in the way. The teacher, in order to initiate some cognitive dissonance, may tell the student to execute the same dribbling skill, but within a confined area and with an opponent attempting to steal the ball. Now the student is faced with how to best execute that skill given the specified parameters. The student must now evaluate his/her competency of dribbling and determine the best way(s) to obtain the objective. Numerous possibilities exist, thereby placing the learning situation and responsibility in the hands of the learner. Through several trials, the student will eventually determine the best way(s) to execute the skill within that situation. As a result, not only has the student practiced the skill physically, but intellectually, the student has had the opportunity to analyze, think, and solve the movement problem on his/her own. As a short or long term result, the student has now been exposed to a more dynamic situation and will be better equipped to act and react when placed in a more formal game-like situation. Along similar lines, Cleland (1994) found that students' creation of various movement patterns was improved significantly when critical thinking strategies were utilized in class.

Not only does the promotion of critical thinking help students take more control of their learning and probe for better and deeper solutions to movement problems, but also may help create a more positive outlook on physical education programs. Administratively, physical education is typically one of the first areas to suffer criticism and one of the first to have to justify why it is necessary. For example, at the secondary level, the rationale for teaching physical education is sometimes questioned (Griffey, 1987; Taylor & Chiogioji, 1987). However, critical thinking and its incorporation into the daily activities of physical education programs may help this content area receive more credibility and strength for future existence and will gradually accentuate the need for daily physical education. Research has also shown successful integration of other content areas within physical education programs (Downing & Lander, 1997; Guthrie & Perea, 1995; Markle, 1991; Tenoschok, 1993). By the incorporation of critical thinking skills, other subject matter can be implemented and taught within the physical education classroom thereby paving a way for interdisciplinary communication and exposure to the students.

Throughout the literature, it can be seen that the teaching and integration of critical thinking into any content area produces positive results both within the student and the environment in which they learn. Neglecting to incorporate critical thinking skills into classes may prove to be detrimental to the full achievement and academic growth of students. With this in mind, it would seem that the extra time and effort that is involved with the planning and incorporation of critical thinking skills into classes is worth the investment in relation to the academic and physical performance of students.

Learning and Gender

Whether it is helping students grasp a new concept in the classroom or helping them perform a complex motor skill on the field, helping students learn is one of the fundamental objectives of every educator. From Gardner's multiple intelligences (Gardner, 1983) to Fitts and Posner's stages of physical learning (Fitts & Posner, 1967), researchers and educators have sought to explain how and why students learn. Questions like "Once presented with the material, how do students process the information for future application?" and "What motivates students to learn?" have generated thoughts, ideas, concepts, and theories that have led us to a better knowledge of how students learn. While several concepts and theories about learning can be applied holistically to all individuals, a distinction that needs to be made and briefly discussed is the manner in which males and females learn. Is there a difference in their learning and if so, how is it different? Why is it different? What can be done to encourage both genders in their endeavor to learn? Although the learning differences between males and females is still not fully understood (Du, Weymouth, & Dragseth, 2003), by touching on the research dealing with this topic, it may provide a brief insight into any differences that may exist in the current study between boys and girls and how they learn when utilizing digital video feedback.

In both the cognitive and physical domains, boys and girls possess many similar qualities with regard to their learning. Any individual, regardless of gender, tends to prefer a specific type of presentation or method for understanding and processing cognitive information. Gardner (1983) proposed seven "multiple intelligences" that help individuals grasp various concepts and ideas. While everyone possesses each of these intelligences, individuals learn best through only one dominant intelligence. Within this same body of research, Sarasin (1998) proposed a differing view of individuals and how they learn cognitively. Rather than learning primarily through "intelligences", Sarasin (1998) suggested that individuals learn best through visual, auditory, and tactile/kinesthetic means. These two views of learning along with numerous other theories (Corno & Snow, 1986; Gregorc, 1985; Johnston, 1997; Ross, Drysdale, & Schulz, 1999; Sims & Sims, 1995) apply to either gender and highlight the commonalities present between them.

In the physical domain, boys and girls also share some commonalities with regard to their learning. In the motor learning literature, some theories about movement and skill acquisition propose stages of learning that all individuals must pass through (Fitts & Posner, 1967; Gentile, 1972). Still others, like Schmidt's Schema Theory (Schmidt, 1975) and Adams' Closed-Loop Theory (Adams, 1971), indicate that the physical learning of skills takes place through schema or representations of the correct movement. More recently, the Dynamical Systems Theory (Magill, 1998) offers an explanation of motor skill learning through a combination of physics, biology, chemistry, and mathematics. These major theories dealing with motor skill acquisition not only examine how males and females learn physical skills, but also give evidence of the similarities between them.

Having highlighted some of the cognitive and physical learning similarities between boys and girls, other evidence in the literature also reveals the differences between them and the manner in which they learn. In the past, current thought led researchers and educators to believe that males and females learned differently primarily due to environmental and cultural factors (Gurian & Henley, 2001). However, this notion of the environment playing such an affluent role may not be entirely accurate. Gurian and Henley (2001) state that "The differences [in learning],…[are] in the brain, with culture playing an important part but not the defining role that many people have wished to believe" (p. 17). What researchers have found reveals that the physiological and structural differences in the brain are responsible for many of the differences existing between the way in which boys and girls learn (Blum, 1997; Gurian & Henley, 2001; Moir & Jessel, 1990). For example, girls' brains develop quicker than boys' (Gurian & Henley, 2001). Because of this early development, girls acquire their complex verbal skills and have a greater range of vocabulary earlier than boys do. Girls are able to express themselves better at an earlier age and are able to communicate their thoughts and feelings in a more coherent manner than boys (Gurian & Henley, 2001). On the other hand, boys tend to have better spatial abilities and abstract reasoning than girls at an earlier age (Gurian & Henley, 2001). This allows them to possess better skills at activities such as measuring, mechanical design, and geography as well as, a better capacity to deal with postulates and theories.

While there are numerous other physiological differences between males and females and their learning, it is interesting to note that girls, on average, are more sensitive to and take in more sensory data than boys (Gurian & Henley, 2001). Since the boys and girls in the current study will be using visual feedback in the form of digital video, it may prove more beneficial to the girls based on this information. If the females in the video intervention perform significantly higher than their male counterparts in the same intervention, it may be attributed, at least in part, to this reason and may provide an avenue for further research with video usage and what can be achieved when used with males and females in separate settings.

Further evidence of learning differences between boys and girls is suggested from the way that girls utilize more of the left hemisphere of the brain than boys (Blum, 1997; Gurian & Henley, 2001; Moir & Jessel, 1990). The significance of this fact comes into play when a response is elicited by a specific task or situation. Because the male brain tends to rely more heavily on the right hemisphere, boys react more directly to a problem or situation in an attempt to solve the problem immediately and efficiently as possible. Females, when faced with the same problem or situation, tend to use more of the left hemisphere of the brain and seek to analyze all possible solutions to the problem or task at hand. Girls, in essence, have a more complex reaction to situations and typically produce other alternatives to solving whatever they face (Gurian & Henley, 2001). In relation to learning a motor skill, it would seem that this factor serves as a double-edged sword for both genders. For males, searching for an immediate and direct solution to the motor skill problem reduces the time of inactivity and increases the time for physically practicing the skill. When using video feedback, boys, rather than overanalyzing the skill, would try to pinpoint their errors more quickly and move more rapidly into practicing the correct response. Girls, using the same video feedback, may be too overly critical of their execution and therefore seek to identify and overanalyze every minute error, thereby reducing the actual time in physical practice of the skill.

While females may decrease their amount of physical activity with the skill, they may produce, as a result of their analysis, a better and more suitable alternative. It may take more time, but the end result may be worth the extra time invested. Boys, although they may engage in more activity time with the skill, may not take the time to plan out alternative methods of executing the skill. This may leave them with the notion that there are only a couple of ways to correctly execute the skill, thereby limiting their options and diminishing their exploration of other viable ways of executing the skill. For example, a boy may quickly view the video feedback of his skill execution and then immediately start trying to correct his error. A girl on the other hand, may spend a little more time viewing her video feedback trying to analyze more of the errors and how to correct them before going back to practice the skill. There are pros and cons to the manner in which both genders learn, practice, and analyze their skill execution. However, these differences do not signify inferiority or a decreased capacity to learn. They just represent how each gender views, processes, and learns the information presented to them. By recognizing this difference in learning, physical educators could design and use digital video more effectively to meet the learning needs of both genders.

While the similarities and differences mentioned in this paper are by no means an exhaustive, in-depth examination of the factors involved in learning across genders, they do point out that there is more to learning than the mere transfer of knowledge from teacher to student. It involves numerous factors that include not only physiological, chemical, and hormonal factors, but also personal learning styles and gender of the individual. By highlighting some of these differences, it may shed some light as to why the males and females involved in the current study may perform better or worse when utilizing digital video.

Motor Skill Performance

As in any educational setting, the primary focus is to help students learn and guide them toward a deeper understanding of the subject matter being taught. While classroom teachers focus on enhancing the cognitive aspects of students, physical education teachers have the unique opportunity to cultivate both the cognitive and physical domains. With the advancements in technology and the broad range of knowledge generated through years of research, physical educators now have numerous resources at their disposal to aid them in their endeavor to help students reach their learning potential.

Within the physical domain, one of the primary goals of a physical educator is to help students acquire the necessary motor skills for everyday living, recreation, and participation in various sports. To ensure that students are learning the skills properly and executing them correctly, it is essential to have an understanding of the concepts behind human movement. Fortunately, during the past century, motor learning researchers have contributed a wealth of knowledge in the areas of human movement and skill acquisition and have postulated several theories and ideas as to how motor skills are learned and performed. By understanding and possessing a working knowledge of these concepts and theories, physical educators can be better prepared to guide students toward improving their skill performance.

One of the early prominent theories that addressed movement production and control was proposed by J. A. Adams (Adams, 1971). His theory, called Adams' Closed-Loop Theory, emphasized the necessity of feedback for movement production and skill acquisition (Adams, 1971). According to this theory, as a movement is produced, feedback is continually acquired from the limbs, muscles, and joints. The internal stimuli gathered from the limbs, muscles and joints, is then stored in the central nervous system as the perceptual trace. Through continued practice, with the presence of knowledge of results (KR) and subjective reinforcement, the perceptual trace grows stronger and begins to represent the standard for the correct movement goal or pattern (Adams, 1971). After developing the perceptual trace during the initial learning stages of a particular movement or skill, it then serves as the reference of correctness to compare incoming feedback. When executing a movement, as the difference in error decreases between the on-going feedback and the perceptual trace, the closer the individual is to achieving the correct position and execution of that movement (Adams, 1971). Since any feedback during the execution of the movement is constantly compared to the perceptual trace, it is essential that the perceptual trace be well developed during the practice phase of a skill. If it is not, then with each skill execution, the quality or correctness of the movement degrades, resulting in decreased learning of that particular skill (Adams, 1971). Succinctly put, if the standard by which the movement is compared is incorrect, then the outcome will be incorrect as well.

In addition to feedback, another aspect emphasized in Adams' Closed-Loop Theory deals with the issue of how a movement is initiated. The perceptual trace, as discussed earlier, is responsible for detecting errors in the movement. However, in order to initiate the movement, it must be chosen from a separate trace. Otherwise, the same system that initiated the movement would provide feedback on that movement. This would cause the feedback to always match the outcome of the movement produced. To address this issue, Adams proposed another system that chooses and initiates the movement. The other system is referred to as the memory trace (Adams, 1971). The memory trace is responsible for the selection and production of the movement. After choosing, initiating, and directing the movement toward the desired outcome, the perceptual trace then assumes control of the movement.

Adams' theory provided an initial explanation for the selection and production of various movement patterns. However, because of the vastness of different motor skills evident in human behavior, his theory seems to be limited in its explanation of some issues surrounding motor skill acquisition. One major limitation of his theory is that it focuses primarily on slow, linear-positioning movements (Schmidt, 1988). When rapid movements are addressed, the factors proposed by his theory do not always hold true or fully explain how the movement was produced or how the errors were detected (Schmidt, 1988).

Another shortcoming of Adams' theory deals with the emphasis of on-going feedback. According to Adams, in order to develop a strong perceptual trace, feedback must be obtained constantly from the limbs, joints, and muscles. During a movement, a closed-loop system is evident for correct movement production. However, several studies using deafferented subjects (Lashley, 1917; Polit & Bizzi, 1978, 1979; Taub, 1976), reveal that on-going feedback from the limbs, muscles, and joints is not necessary to generate the correct movement. While the role of feedback is vital to the learning of motor skills, the necessity for continual feedback from the limbs, joints, and muscles to help generate the correct movement pattern is questionable.

A final limitation of Adams' theory is evident in the way practice is viewed. Because the perceptual trace, according to Adams, is strengthened through practice and since it represents the standard that incoming feedback is compared to, any deviation in practice that does not reflect the exact movement outcome could prove detrimental to the learning of that movement. Indications from other studies involving practice (Schmidt 1975; Shapiro and Schmidt, 1982) however, contradict this characteristic of Adams' theory by showing that variability in practice does not hinder motor skill learning.

Although Adams' Closed-Loop Theory had some limitations regarding movement production, the information shared within the theory and the ideas it provoked marked it as a solid stepping-stone for theorists to utilize in the upcoming years. Shortly after Adams' theory was being tested and applied in motor learning research, Gentile (1972) compiled some thoughts and ideas regarding skill acquisition and approached the topic from a more practical standpoint. Her explanation, or model, viewed skill acquisition and motor performance from a learner's perspective with a more goal-oriented focus.

Gentile's model (1972) proposed two major stages in the learning of motor skills. The first stage, referred to as getting the idea of the movement, focuses on what the individual must do to achieve the correct movement outcome (Gentile, 1972). In order to attain the desired movement response, the individual must learn to differentiate between the essential and non-essential information within the environment that may influence his/her movement. Regulatory conditions are pieces of information about the performance environment that are essential to the correct outcome of the movement (Gentile, 1972). Aspects such as the position of an opponent or distance to the goal would influence whether or not a movement was executed in a particular way. Knowing where the opponent is or how far the goal is in relation to the individual is information that is important to the learner and must be processed in order to achieve the desired outcome. Non-regulatory conditions can be thought of as information obtained from the performance environment that does not influence the outcome of the movement (Gentile, 1972). Factors such as the color of the ball being used or the type of uniform being worn represent non-essential characteristics that would not affect the outcome of the movement.

Once the individual has acquired the basics of the movement during the first stage and can differentiate between regulatory and non-regulatory conditions, then the second stage called fixation/diversification begins (Gentile, 1972). While in this stage, the individual focuses on adapting the movement to the demands present in the environment, strives toward consistently reproducing the desired outcome, and attempts to perform the movement with minimal effort (Gentile, 1972). Gentile explains that the fixation characteristic of this stage relates to skills performed in a closed environment. Closed skills, or skills performed in a closed environment, are less affected by environmental variables such as opposing teams, players, or obstacles. Because of the stability and reduced variability in the environment, the individual is able to practice the skill in almost the same manner as it would be performed. Therefore, the learner is able to fix or focus their attention on reproducing the same movement outcome for every attempt rather than dividing their focus between the movement itself and the changing environmental variables. For instance, in shooting a basketball free throw, there are no opponents attempting to block the shot or move in front of the goal. The way a free throw is shot during a game situation will be very similar to the way a free throw is shot in a practice situation. This “fixation” stage allows the learner to concentrate his/her attention more heavily on the development of the form and technique so that a more consistent outcome can be produced. Other closed skills like golf, serving in tennis, and gymnastics accentuate the need for the learner to consistently reproduce the correct movement outcome after every execution of the skill.

The diversification characteristic of the second stage in Gentile’s model applies to open skills (Gentile, 1972). Open skills, unlike closed skills, are performed in environments that constantly change. Because of the ever-changing variables present in open skills, individuals must focus on adapting their movement to achieve the desired outcome. Unlike closed skills where the learner must fix his/her attention on the skill itself, open skills require the learner to diversify or divide their attention between the environment and the execution of the skill. This division is necessary so that a skill may be properly executed according to the changes presented within the environment. Take for example the skill of dribbling a soccer ball. In a game, there are teammates and other opponents present. Because of these variables, the direction, speed, and force required to dribble down the field on one attempt will have to be adjusted and changed for future attempts. This would be evident by the fact of the different positioning of teammates and the changing defensive strategy used by opponents.

In summary, Gentile's model (1972) states that an individual learning a particular skill will pass through two stages. The first stage, getting the idea of the movement, is the period in which the learner grasps the basic concept and movement patterns of the skill as well as, discerns between regulatory and non-regulatory conditions. Once the individual has learned the basics of the movement pattern and has been able to separate between necessary and unnecessary environmental information, then the second stage begins. Fixation/diversification, the second stage of Gentile's model, marks the period in which the learner strives toward consistently achieving the correct movement outcome in relation to the environment he/she is performing in. Skills performed in closed environments place little or no demand on the individual to adjust their execution of the skill. The individual focuses primarily on the skill itself and how to consistently reproduce the same results time after time. On the other hand, open skills place heavy demands upon the individual to alter his/her movement pattern in order to achieve the desired outcome. Factors present in an open environment are constantly changing, thereby forcing the execution of the skill to be constantly altered.

A few years after Adams' Closed-Loop Theory and Gentile's model became evident in motor learning literature, another theory addressing motor skill acquisition was presented. Schmidt's Schema Theory or open-loop theory (Schmidt, 1975; Schmidt, 1988) drew heavily upon Adams' Closed-Loop Theory and sought to explain movement production through the use of two memory states with an emphasis on a generalized motor program. The two memory states evident in Schmidt's Schema Theory were called recall memory and recognition memory (Schmidt, 1988). The former memory state was responsible for the production of the movement and the latter was responsible for the evaluation of the movement. Unlike Adams' emphasis on feedback, Schmidt emphasized the generalized motor program (GMP) as a means for storing a class of actions with various parameters and information necessary to properly perform the skill with the desired outcome.

After executing a movement using a GMP, Schmidt's theory proposed four factors that are stored and utilized for the building of the schema. The first component stored after a movement has been executed is the initial conditions (Schmidt, 1975; Schmidt, 1988). This information refers to factors present before the movement is initiated. Body position, limb angle, and weight of any thrown objects are examples of information that would be stored with the initial conditions. The second component stored would be the parameters (Schmidt, 1988) or the response specifications (Schmidt, 1975) of the movement. This component stores information involving the speed of the movement and the forces involved to propel an object or the body within the environment. Another component stored after a movement execution is the actual outcome of the movement (Schmidt, 1975; Schmidt, 1988). This information is provided to the learner through knowledge of results (KR) and subjective reinforcement. Lastly, the fourth component stored is the sensory consequences of the movement (Schmidt 1975, Schmidt, 1988). The sensory consequences refer to how the movement felt, looked, sounded, etc. as it was being executed. It is closely related to the kinesthetic feedback individuals receive from performing skills in gymnastics or in other closed skills like driving a golf ball.

Once this information is stored, relationships or schemas start to be formed by the learner (Schmidt, 1975; Schmidt, 1988). As each movement is performed, whether it is exactly the same as the original movement pattern or similar to it, the schema is strengthened. One relationship or schema formed from the stored components is the recall schema (Schmidt, 1975; Schmidt, 1985). The recall schema, like Adams' memory trace, is responsible for the production of the movement. The formation of this schema requires the learner to piece together the initial conditions and the actual outcome of the movement. These two factors then are paired with the parameters of the movement. From this point forward, the learner will possess the necessary information to select and initiate the correct movement pattern for the desired outcome based upon the relationship made between the initial conditions, actual outcome of the movement, and the parameters.

The second schema, called the recognition schema, evaluates the movement response (Schmidt, 1975; Schmidt 1988). Similar to Adams' perceptual trace, the recognition schema serves as a point of reference in which to compare sensory feedback. The recognition schema is formed through a manner that is similar to the recall schema, but with a slight difference. Like the recall schema, the learner must formulate or connect the initial conditions of the movement to the actual outcome produced. However, for the recognition schema to be formed, instead of relating the initial conditions and actual outcome to the parameters, the learner must relate these factors together with the sensory consequences (Schmidt, 1975; Schmidt, 1988). By formulating a relationship or schema between these factors, the learner will be able to estimate and evaluate the movement outcome resulting in better accuracy for future attempts. Through subsequent attempts of a movement, the recall and recognition schema work in conjunction to guide the learner closer and closer to the desired outcome.

Although Schmidt's and Adams' theories parallel each other in some respects, a factor that differs greatly between the two is the role in which feedback plays. In both theories, KR is vital during the early stages of practice. This is so the learner can establish a good basis in which to refer to or compare the executed movement. Where the difference arises is after the foundation has been laid for the correct movement. Schmidt states that KR is not as vital at this point to maintain the learning of a movement (Schmidt, 1975). Although KR is more precise and desirable to receive, if it is not present, the learner may use subjective reinforcement to determine the outcome errors. Since this is the case, Schmidt treats this error labeling as another schema that a learner can use to help in updating the recall and recognition schema for that movement. In opposition to this view, Adams states that feedback, specifically KR, must be present to continue learning the movement (Adams, 1971). If it is not, then learning is degraded after each trial without KR. Thus, the withdrawal of KR degrades the perceptual trace, thereby proving detrimental to learning (Adams, 1971).

One other factor that differs between Adams' and Schmidt's theories is the manner in which practice is viewed. So that an individual may develop a wide range of experiences for building the schema, Schmidt supports variability during practice (Schmidt, 1988). By slightly altering the parameters for a particular GMP, Schmidt and others (Shapiro & Schmidt, 1982) have found that this variability in practice enhances, rather than hinders the learning of a motor skill. Adams' theory sees any deviation from the exact movement pattern as ineffective and possibly detrimental to learning (Adams, 1971).

Up until recent years, motor learning theories and concepts have typically been based and grounded on characteristics common to the field of psychology. These psychological undertones are reflected in terminology such as the motor program, schema, and memory trace. Within the last decade though, one theory has emerged that approaches skill acquisition from a framework that is based outside of psychological principles. This theory, called the Dynamical Systems Theory (DST), attempts to explain coordinated movement by observing the interaction that takes place between the disciplines of physics, biology, chemistry, and mathematics (Magill, 1998).

Unlike its predecessors, the DST adheres to the idea of nonlinear dynamics. When acted upon by internal or external forces, movement patterns in nature, like ripples in a lake or water flowing down a stream, do not always occur in a linear fashion. Thus, in order to explain the changes in the particular movement pattern, nonlinear mathematical equations must be used. This same principle, according to the DST, applies to human movement as well (Magill, 1998). As changes occur in a particular movement, the stable state of that movement is affected. By utilizing the explanation provided through the various disciplines of science, the DST attempts to identify how and when the movement change took place as well as, the time necessary for the movement to return or change to a new stable state (Magill, 1998).

Where other theories have built upon GMP's and schemas for the basis of explaining human movement, the DST revolves around the concept of stability (Magill, 1998). Stability refers to the natural tendency of any system to return to a steady state once it has been acted upon by another variable. By studying the stable state of a system or movement, then researchers are able to understand better the variables that produce a change in the movement. In human movement, the steady state is referred to as the preferred behavioral state (Magill, 1998). This is the state at which a movement will naturally occur if performed without any external variable acting upon it. While a movement is at its preferred behavioral state, it is also at its most energy-efficient state (Magill, 1998). During this state, the movement can be produced and executed with a minimal amount of energy.

Since the DST theory is based on explaining movement through nonlinear equations, certain factors exist that help identify the components needed for the equations. Two of these factors are referred to as the collective variables and control parameters. Collective variables, or order parameters, are abstract variables that define a particular movement pattern (Magill, 1998). For example, some collective variables inherent in discrete aiming movements are the relative phase of the movement, equilibrium points, and muscle stiffness. On the other hand, control parameters are aspects that change according to the specific characteristics of a movement (Magill, 1998). Examples of control parameters may include speed or force.

The remaining factors that aid in the formulation of nonlinear equations for human movement are self-organization, coordinative structures, and perception and action coupling (Magill, 1998). Self-organization, similar to Schmidt's motor program, is responsible for producing a movement that is influenced and formed by its environment. Unlike Schmidt's explanation, the self-organization variable states that the movement is formed as a result of the environment acting upon it rather than from a pre-stored movement pattern. Coordinative structures involve the synergistic action of numerous muscles and joints to produce a skilled movement (Magill, 1998). Through practice and/or experience, the coordinative structures can be formed and strengthened. The last factor, perceptual and action coupling, is the interaction of perceptual and motor variables acting together to produce the desired goal of the movement (Magill, 1998).

By observing these variables produced during a movement, an equation can be formulated that intertwines the various disciplines of science. Through the compiled variables in the equation, an explanation can be attained of how the variables affect the production of the movement, the accuracy of the outcome, and the efficiency with which the movement was executed. As the study of human movement develops and the influence of numerous variables are studied and recorded more in depth, the DST may provide a better understanding of how motor skills are acquired. However, because of its relatively new perspective and limited research, it may be some time before it becomes widely accepted as previously established theories.

Feedback and Motivation

To reach their goal of helping students acquire the necessary motor skills for various activities, physical educators need to possess not only a working knowledge of the basic principles and theories underlying motor skill acquisition, but also the means with which to convey and apply this theoretical knowledge to their students. One medium that has provided a bridge between this theoretical gap and classroom application is feedback. When coupled with a sound knowledge of human movement, feedback has the potential to be one of the most important factors in skill acquisition (Bilodeau, 1966; Newell, 1974; Singer, 1975, 1982; Zecker, 1982), especially during the early stages of practice (Adams, 1971; Skinner, 1958). With the presence of feedback, students receive valuable information that helps them learn the skill correctly and in a significantly less amount of time. Without feedback, the time to learn a skill would take considerably longer and the possibility of learning the skill incorrectly would be higher.

In the body of motor learning research, feedback can be broken down into two major categories, intrinsic or extrinsic (Schmidt, 1988). Other researchers have also referred to these categories as task-intrinsic and augmented feedback (Magill, 1998). For the purposes of this discussion, task-intrinsic and augmented feedback will be used. Task-intrinsic feedback refers to the information an individual receives from the various sensory channels during or after a movement is performed (Magill, 1998; Schmidt, 1988). It provides the learner with subjective information about his/her movement in terms of how the movement felt or what it looked like. For example, a gymnast performing a handstand can “feel” if his/her legs are in-line with the rest of his/her body. Also, immediately after a basketball player releases the ball for a free throw, he/she can sense or “feel” whether or not the ball will go in the basket. The use of task-intrinsic feedback enables the learner to receive a kinesthetic awareness of their movement through visual, tactile, auditory, and proprioceptive means.

On the other hand, augmented feedback is information that is received in addition to task-intrinsic feedback and from a source that is external to the individual (Magill, 1998; Schmidt, 1988). Whether from the verbal comments of a physical education teacher or visual cues presented in a video, augmented feedback provides the learner with a different perspective and viewpoint about his/her execution of the skill and the possible corrections that need to be made in order to successfully learn the skill. Because augmented feedback originates from someone or something outside of the individual, it allows coaches and physical educators the opportunity to share their knowledge regarding human movement on a level that best suites their learner's needs. As a result, they are able to better guide their students toward the proper development of motor skills.

In the motor learning literature, augmented feedback can be further divided into two distinct categories. Information given to the learner about the outcome of the movement is referred to as knowledge of results or KR (Magill, 1998; Schmidt, 1988). When given during a movement, (concurrent augmented feedback) or after it (terminal augmented feedback), KR conveys to the learner information about whether or not the movement goal was accomplished. The KR given to an individual can range from being very broad and general as in statements like "You missed the shot" to highly specific statements like "You missed the target by 2 inches to the left and 1 inch down." Although KR is helpful in numerous activities, skills, and laboratory settings, when used as the sole source of feedback in some cases, it may not be as useful.

At this point, the second category of augmented feedback known as knowledge of performance or KP can be utilized to build upon the information already received through KR (Gentile, 1972; Magill, 1998; Schmidt, 1988). While KR relates to information about the performance outcome, KP provides feedback on the actual movements or motion used to achieve the outcome. Take for instance a student attempting a tennis serve. After the student serves the ball and fails to get the ball over the net, the teacher may say to the student, "I noticed that your racket face was slightly closed and you did not contact the ball at its highest point." The statement given by the teacher in this example provides the learner with information about the movement itself and the reason why that movement produced the error. The learner has received KP and now can process the information for future attempts. Knowledge of performance feedback can be made verbally, as in the example above, or it can be made non-verbally as in the case of computer-based instruction, biofeedback, or video. When coupled together, KR and KP have the potential to provide many of the necessary components for helping students and athletes learn the skills being presented to them.

As Schmidt (1988, 1991) points out in his discussion regarding feedback, KP provides the learner with information pertaining to the form, technique, and execution of a specific movement. While this type of augmented feedback helps to inform and guide the learner toward a better and more efficient skill execution, it also serves as a motivational factor (Magill, 1998; Schmidt, 1988, 1991). Schmidt states that augmented feedback, in addition to its corrective function, serves as a means of increasing the learner's enthusiasm and helps to revitalize the learner's drive in achieving the desired outcome. What this translates into is that the learner tries harder and becomes more willing to continue practice (Schmidt, 1991). Video, since it can serve as a means of augmented feedback, presents physical educators with an alternate yet innovative method of supplying augmented feedback to their students. Rather than merely state the errors made or verbally praise the correct aspects of the execution, video adds another dimension to the augmented feedback by visually portraying the student and his/her skill attempts. Seeing themselves on the monitor or TV screen allows learners to be more actively involved with correcting their errors and provides that extra incentive to keep on trying. Also, since many present-day students already enjoy using video and are familiar with it, the potential for increasing their interest in the activity is increased. If their interest and motivation for the activity increases, it can have an eventual effect on the acquisition of the skill. Findings from a recent study comparing video instruction and still-photograph illustrations indicated that subjects in the video group showed a significantly higher rating in motivation to perform the exercises and also felt significantly more confident in their ability to correctly perform the exercises (Weeks, Brubaker, Byrt, Davis, Hamann, & Reagan, 2002). This same study reported that the video group also had significantly higher ratings of form both in the acquisition and retention phases of the exercises they were attempting. Along the same lines, Jambor and Weekes (1995), in their study with college-age beginning swimmers, also gave evidence that video increases motivation and effort. From a social-cognitive approach, Bandura (1997) points out that enabling individuals to view a self-model of their own correct performance leads the individual to a better understanding of the skill and strengthens his/her self-confidence to perform the skill.

In conjunction with providing a positive, motivational component in skill acquisition, video further enhances the affective domain by offering teachers and students a different method for presenting and receiving information that is typically repetitive and mundane in nature. Factual information like sports rules, sport history, and health/nutrition rarely change. Because of this, teaching and reviewing the same rules, concepts and information year after year soon gets monotonous and extremely boring. However, Mohnsen (1997) has explored some of the more creative possibilities with video and how it can be used in a variety of ways to create a more interesting and appealing learning environment. Use of videotaped scenarios or ones created by students can help physical educators present sports rules in a fashion that actively involves students and at the same time conveys the concepts and ideas necessary to understand the rules (Mohnsen, 1997). It would be easier to print the rules on paper and hand them out, but the probable reaction from students would likely be indifference and boredom. Further use of video can involve students making video commercials that promote healthy lifestyles, nutrition, or on whatever topic that is currently being covered in their health class. Actively engaging students and encouraging them to display their understanding of the rules, concepts, and terminology through video scenarios or other creative video displays, gives a more complete picture of their understanding and presents a much more innovative and enjoyable method of learning factual information. In the literature, physical educators have revealed other creative uses of video which include digital video demonstrations (Anderson, Mikat, & Martinez, 2001), as an assessment tool (Anderson, Mikat, & Martinez, 2001; Melville, 1993; Mohnsen, 1997;), as a means of showcasing students and their progress (Anderson, Mikat, & Martinez, 2001; McKenzie & Croom, 1994), and as a research tool (McKenzie & Croom, 1994). Integrated appropriately, video can be used as a valuable tool in the effort to raise interest, motivation and confidence levels of students.

Video Technology in Education

Physical educators, as a result of extensive research throughout the past several decades, now have the opportunity to obtain a clearer understanding and better comprehension of how motor skills are acquired and the factors involved in teaching those skills to students. Although physical educators may possess a good knowledge base of motor learning theories and feedback, several challenges still exist that must be overcome. Challenges like over-crowded classes, decreased equipment availability, and a plethora of student learning styles and skill abilities all pose as barriers in the endeavor to teach motor skills effectively. Unfortunately, these challenges that are faced by so many have no clear-cut solutions. However, one factor that has the potential to address these challenges and become an effective teaching tool for physical educators is technology. With its multi-dimensional approach to learning, technology has the potential to help create a rich, learning-oriented environment when utilized with good teaching practices.

For the past several decades, technology has gradually infiltrated nearly every facet of society. Unlike twenty years ago, when cellular phones and personal computers were considered a luxury, it is now more commonplace to see these items in homes, schools, and businesses. With this ever-growing popularity and appeal of technology, students in schools have now come to demand more than standard lectures to keep their attention and stimulate their thought. Amidst this technological growth, education has addressed the learning needs of current students and has taken advantage of the opportunity to utilize various pieces of technology to extend, enhance, and promote student learning. Video technology is one area that has facilitated change and aided educators in the battle to keep students not only interested and wanting to learn, but has helped to promote and encourage higher order thinking and analysis.

Generally speaking, video technology encompasses any component or device that records events or activities onto a medium that allows for playback on a television or monitor. Earlier mediums included items such as Beta, VHS videocassettes, and laserdiscs. But with the more recent advances in technology, mediums such as compact discs (CD's) and digital videodiscs (DVD's) have made it possible for video to be either viewed in its original state or interactively during playback. Since the introduction of analog video back in 1977, video technology has taken enormous strides toward better quality and more economic availability. From basic loop films to DVD's, video technology has played an important role in educating students in various classrooms and learning environments. To evaluate the effectiveness and use of video and television in the classroom, the Corporation for Public Broadcasting conducted a study involving over 1,200 teachers and over 1,000 principals throughout the United States during the 1996-1997 school year (Corporation for Public Broadcasting, 1997). According to this study, over 90% of the participating teachers stated that video and television helped them teach more effectively with another 88% saying that it provided another avenue for creativity (Corporation for Public Broadcasting, 1997). The participating teachers also felt that the use of video re-enforced their lecture presentation of the material. Further results showed that teachers observed very positive student outcomes, such as increased motivation and enthusiasm as well as, increased learning when video was used in their classes (Corporation for Public Broadcasting, 1997). This study gives evidence that video can address the diverse learning needs of today's students and help produce positive outcomes.

In addition to addressing various learning styles, video can serve as a platform for new discussions as well as, encourage and promote collaborative work among students. Video technology has also provided a means for students to travel on virtual tours of far away lands and cultures they would otherwise never get to see or experience. To illustrate this, a middle school geography teacher showed a video documentary of the Bosnian War to his students and then created an assignment for the class to complete (Tillman, 1999). The teacher required them to create a thirty second movie clip and an accompanying essay that described what the war was about and what it meant to both sides involved. Through this creative use of video, the teacher encouraged collaboration among the students. As the students worked on the projects in groups, each individual had to discuss what part they felt portrayed the true meaning of the conflict and why. After this discussion, group members would then capture various video clips that embodied the feeling, emotion, and thoughts about the war. Following the editing of the captured clips in a digital video-editing program, students then had to jointly write an essay explaining their thoughts about the war and why they chose their particular video clips. As a result from this assignment, the participating teacher reported that the students produced outstanding projects and put a lot of thought and effort into their work (Tillman, 1999). The use of video in this study provided a means for discussion among students as well as, a platform for critical thinking and content analysis. Having the students discuss their feelings and thoughts surrounding the war made them think and reflect on different viewpoints and perspectives. The discussions elicited from the video served as a catalyst to help the students weigh the differing opinions and combine the group's feelings about the war into a cohesive presentation. Students also were exposed to and involved in the active use of other technologies such as video editing software and word processors. This video, in conjunction with the creativity and planning of the teacher, enhanced the students' learning experience, gave them a different view of a particular time period and event, and helped the content become more real to them (Tillman, 1999). Students were able to catch a rare glimpse of the tragedies and suffering of war by watching the footage and seeing everything as an outside observer. Trying to achieve the same outcomes with the sole use of lecturing is almost, if not impossible.

Not only has the use of video shown positive results with general education students, but other literature suggests that individuals with learning disabilities can benefit as well (Engelmann & Carnine, 1989; Woodward & Gersten, 1992). Because of the increased availability, affordability, and enhancements of current video technology, teachers are able to use this as a medium for all students, regardless of whether or not an individual possesses a learning disability. Vivid animations, interactive components, and multi-sensory output are a few of the numerous methods that video provides to help students "think outside the box" and challenge them to generate different ideas and interpretations (Wissick, 1996). With the emergence of digital video technology such as DVD's and digital video cameras, students can now find information and resources more efficiently and can express themselves through a different medium (Dessoff, 2001). Since digital video lends itself to editing very easily, students, especially those who may not be able to read and write very well, are able to use this as another tool for expressing their thoughts and ideas (Dessoff, 2001). For other students who may be homebound or absent from classes, digital video provides a way for teachers to edit their lectures/lessons and either send home a videotape of the session or place it on the Internet using streaming audio and video. Other educators have capitalized on the more advanced uses of video by conducting videoconferencing sessions and on-line mentoring either within their state or across the world with other students or teachers (Dessoff, 2001).

Throughout the body of general classroom research, it is evident that the use of video provides an enhancement to students, the learning environment in which they are placed, and the learning process. Like teachers in other content areas, physical educators have the opportunity to integrate video technology with their teaching style and curriculum, thereby increasing the potential to help address numerous learning styles, promote student learning through critical thinking and problem solving, and provide an alternative to standard teaching methods. Because the inherent nature of physical education is to address both the physical and cognitive domains, trying to understand and incorporate all of the concepts, ideas, and factors involved with motor skill acquisition and video usage can be overwhelming. Nevertheless, when viewed holistically and implemented gradually within a physical education curriculum, motor learning, feedback, and video are all pieces of the same puzzle that fit together nicely when integrated with good teaching practices.

During the initial stages of learning a motor skill, visual feedback is considered an essential component (Adams, Gopher, & Lintern, 1977; Bandura, 1971, 1977; Fleishman & Rich, 1963; Gagne & Fleishman, 1959; Rikli & Smith, 1980; Rock & Harris, 1967; Rothstein, 1980). According to a study by Schmidt and Wrisberg (1973), if individuals have various types of sensory feedback available to them, they will typically depend upon their vision more heavily than other forms of feedback. The use of video provides students with visually augmented feedback and helps to accentuate the individual components involved in learning and executing a skill. Many physical education teachers and coaches have realized the importance of visual feedback and as a result, tried to provide a live, visual demonstration of how to correctly perform the skill being taught. Needless to say, the possibility that every student fully understands how to practice and execute the skill from a live demonstration alone is very small. Factors such as the students' angle of view/perspective and the speed of the demonstration many times may cause students to have trouble in learning or practicing what they saw. Being exposed to and viewing a correct model of the skill is very important, but in order to facilitate improvement, Melville (1983) states that there must be an opportunity for an individual to "…take a visual comparison between [his/her] performance and the correct performance model" (p.96). Viewing a full-speed, live peer or instructor demonstration alone does not provide this component of self-evaluation.

Traditionally, to compensate for the lack of visual information, loop films have been used to demonstrate model performances in conjunction with instructor demonstrations. However, with the enhancements made in technology, the use of loop films has significantly declined over the years. Limited accessibility, bulky projectors, and less than average picture quality have made loop films almost obsolete when compared to current video technology like VHS, CD's, DVD's, and interactive videos. Present technology offers much better picture quality, a more accessible and user-friendly interface, and a variety of playback speeds and options. With current video technology, learners can more readily access and view a model performance and use the guidance provided by an instructor, criteria sheet, or coach to determine the stages of the skill they may have had difficulty in seeing or understanding during the live demonstration. A current example illustrating the versatility and instructional element available with video is the MASS (MultiMedia Analysis of Sport Skills) program developed by McKethan and Everhart (1997). This video series provides students not only with a correct model performance of a particular motor skill that can be shown from various angles, it also utilizes still pictures, graphics, text, and cues to further explain and clarify the skill being performed. In essence, video allows students to visually piece together and evaluate the movement at a pace that is comfortable for their learning speed. While some students may have no problem viewing and learning the skill at full speed during the instructor's demonstration, other students who are not so athletically inclined may need the additional time and visual feedback to learn the skill.

The use of video gives students a chance to view a model performance frame-by-frame or in slow motion to see what is happening in each stage of the movement. By doing so, students have the potential to better understand the factors involved in the skill more so than with a one-time demonstration. This factor ties in nicely with Gentile's model (1972) of motor skill acquisition. In the first stage, learners must get the idea of the movement. Gentile expressed the need for learners to first understand the movement and how it is performed before progressing to the next stage of motor skill acquisition. With video, learners have the opportunity to view the movement at their own pace, gather the information about the form and technique of the movement, and process the information for immediate practice. Also, when students view a model performance on video, they can gradually learn to focus, with the help of an instructor or coach, on the pertinent information related to executing the skill, another factor that Gentile (1972) states is vital in learning motor skills. Through the combination of the visual information provided by the instructor's demonstration and the video, students may be able to obtain a clearer understanding of the skill being taught, thereby giving them a better "idea of the movement" and what it involves. Although live demonstrations by the instructor or peers is still an integral part of teaching skills in physical education, the practice of relying solely on live demonstrations decreases the possibility for all students to efficiently learn the skill, especially for those who prefer visual feedback and the extra time to process it.

Along with supplementing live skill demonstrations, the use of video helps fill another piece of the motor learning puzzle by providing an avenue for physical educators to address the cognitive domain. Time and again administrators, principals, and parents fail to realize that physical educators also have a responsibility to help students take a more active role in their learning both physically and cognitively. Many times, parents and other school personnel question the rationale of written tests, homework, and the necessity of having physical education (Griffey, 1987; Taylor & Chiogioji, 1987). To add to this constant scrutinization, overcrowded classes also pose a major barrier in helping students actively learn from both domains. Having to teach classes of forty to fifty students within a forty-five minute period places physical educators in a tough and challenging situation (Melville, 1993). Unfortunately, within these large classes, physical educators have very little one-on-one or small group interaction with their students, thereby limiting the feedback that is given to them. Although video will not completely solve these problems faced by many physical educators, it does have the potential to improve the overall learning environment (Anderson, Mikat, Martinez, 2001) and empower students to take more responsibility for their learning.

Video and Learning Within the Physical Education Environment

According to Mosston and Ashworth (1994), empowering students to take more responsibility for their learning is a vital part of the learning process that needs to be emphasized. Through their study and research on various teaching styles, Mosston and Ashworth proposed a spectrum or continuum of eleven styles that could be utilized by educators in their physical education classes. The first few styles, or styles A through C, are part of the reproductive styles that place the majority of the decision-making process and the responsibility of giving feedback in the hands of the teacher. Essentially, when teachers incorporate these styles into their teaching, students have very little choice in what they do, how they practice, or whom they practice with. These initial teaching styles that primarily utilize direct instruction are not necessarily bad to use. In fact, research definitively shows that direct instruction is necessary for different types of skills and skill levels (Rosenshine, 1987). However, in order for students to grow cognitively, teachers must allow students to gradually progress toward the productive styles by releasing control of different aspects of their learning. As the spectrum moves away from the reproductive styles and progresses toward the productive side of the continuum, learners are gradually given more and more responsibility for their learning and become more independent of the teacher. Ideally, every teacher would like to implement the final teaching style, called style K or the self-teaching style, with his/her students. To have students taught using this style indicates that the class has reached a point in their learning in which they are ready to initiate their own learning and pursue the knowledge on their own, apart from any assistance from a teacher. Granted, this style is typically not implemented in school physical education classes since the structure of the environment and various other stipulations dictate the involvement, or lack thereof, of the teacher. Nevertheless, the progression toward this self-initiated learning is a goal that is worth striving for. In this endeavor to help students progress toward initiating their own learning, video can serve as a catalyst to help bring about this positive change. For example, if a physical education teacher had classes that functioned adequately within a reciprocal or self-check teaching style, students, whether in pairs or in small groups, could videotape each other's skill performance and then immediately view what they did. In addition to the instructor's demonstration and verbal feedback throughout the class period, students would then be able to receive augmented visual feedback about their performance through the videotape and immediately engage in a critical analysis, with the aid of a criteria sheet or picture of a model performance, of their own execution of the movement. Doing so would provide the opportunity for students to cognitively assess their own skill and try to problem-solve and correct the mistakes they may be making without the constant assistance of the teacher. By allowing students this cognitive freedom or self-regulation (Zimmerman, 1994), they are able to gain control over some of the aspects of their learning. When given this control and the freedom to regulate the amount of feedback received, research has shown improvements in learning and performance (Janelle, Kim, & Singer, 1995; Schneider & Pressley, 1989; Seigler, 1991) and better retention of crucial information (Hardy & Nelson, 1988; Holt, 1982; Zimmerman, 1989). A more recent study that dealt with the issue of self-regulated learning supported the idea that giving learners some control over their learning was beneficial. This study, which utilized a throwing task with the non-dominant arm, showed that participants who controlled the quantity of KP they received from the instructor performed better and retained more than the three other experimental groups (Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997). From a cognitive standpoint, video is a medium that would help facilitate an atmosphere conducive for self-regulated learning, which in turn, enhances overall learning. According to Janelle et al. (1997), incorporating self-regulated strategies within a class "…allows for guidance but provides an environment in which one is encouraged to learn for oneself" (p. 277). While evidence for allowing students more control of their learning is supported in the literature, it does not imply that the physical education teacher or his/her feedback is not necessary. What video usage does provide is an avenue that can help students develop intellectually and increase their potential for thinking, reasoning, and learning on their own.

Not only would video provide students with the chance to cognitively assess and analyze their own skill performance, but it would also offer them the opportunity to analyze, critique, and help improve their peers' performances as well. Mosston and Ashworth (1994) incorporate peer evaluation and collaborative learning as useful techniques to help students progress toward self-initiated learning. Although training and repetition are required to help students consistently record and obtain accurate observations of the skill being practiced, the time invested in doing so will aid students in learning future skills. Christine Brooks (1980), a former track coach at Pennsylvania State University, saw a marked improvement in four of her sprinters after they helped her conduct a weekend sprint camp. According to Brooks (1980), since the four advanced sprinters provided analyses and instruction to the beginning sprinters, their understanding of the movement was enhanced and they gained a clearer picture of how the movement should be executed. Both the beginners at the camp and the advanced sprinters benefited from the peer instruction and collaboration. Similar to this is the reciprocal teaching style proposed by Mosston and Ashworth (1994). In this teaching style, students watch their peers perform the skill being taught and then using a criteria sheet, identify the places where the performance deviated from the model. Because of technology like digital video, the observer can immediately tell the doer what was right or wrong with the movement and also show him/her, at a much slower and more visible speed, when and where the errors occurred. Herbert and Landin (1994), in a study done with beginning tennis players, found that beginners who watched others practice the forehand volley learned the skill better than those that received only verbal KP. Further results from their study indicated that learners who watched video of others practicing and then received augmented verbal KP from the instructor performed the best in comparison to the other experimental groups. For physical educators, video could provide assistance in the dissemination of feedback to both individuals and small groups while addressing the cognitive aspects of the skill as well.

Next to the research addressing the physical and cognitive domains lies another piece of the motor learning puzzle that appears insignificant on the surface, but when given a deeper look plays an important role in skill acquisition and improvement. Unlike humans, which have neither the patience nor the ability to infinitely repeat a skill demonstration, video allows the learner a virtually endless number of replays that can be accessed very easily and watched at various speeds. Because of the number of replays available through video, the learner is presented with more opportunities to update the schema related to the skill. According to Schmidt's Schema Theory (1975, 1988) discussed earlier in this chapter, after each execution of the skill, four characteristics pertaining to that movement are stored in memory for future attempts. The general motor program (GMP) then uses the information provided by the recall and recognition schemata to execute and refine the movement so that it is more closely related to the model performance. While physically performing the skill updates the schemata, Schmidt also states that KR and subjective reinforcement must be present, at least in the early stages, to help strengthen and build a good foundation for the GMP. Since video provides both KR and KP, using it to play back various skill attempts over a period of time may help strengthen the schemata and aid in the building of a good foundation for the GMP. With each execution of the skill, the schema that is responsible for initiating and running the motor program is constantly updated. Whether practice trials are correctly or incorrectly executed, viewing and comparing them to the model performance still contributes positively to the updating of the schema. Unlike Adams' (1971) theory where errors are seen as detrimental to performance, Schmidt's theory views them as another means of updating the schema. Whether the video is of the individual or of another classmate, watching the skill as it is being executed provides an opportunity for the learner to analyze and compare the movement to the model. By taking into account the initial conditions, the actual outcome and the sensory consequences from the video, any deviation from the model can be isolated, analyzed, and used to update the recognition schema so that future attempts will be closer to the correct performance. Due to the difficulty many physical educators have in relaying feedback to every student during class, video may prove to benefit students in their skill performance by providing another means to update and strengthen the GMP while offering physical educators an additional method of providing augmented feedback.

Integrating Video

As evidenced by the research literature, physical educators, coaches, and general education teachers have discovered many of the unique benefits video has to offer when implemented within various learning environments. Additional augmented feedback, higher levels of interest, and a platform for teaching self-analysis and problem-solving skills are just a few of the positive aspects inherent with the use of video. However, as with any type of teaching method or tool, educators must consider how they will approach the integration and implementation of video into their classes. Probably the first questions that spring into the mind of any physical educator are the cost of the equipment and the time investment. More so than these, the bottom line of whether or not to use video rests ultimately in the question that deals with learning. For example, if the students are not ready in the teacher's opinion to embrace an alternative method of learning such as video, then it may not be the best answer. So in order to gain a better idea in determining whether or not to use video, research has provided one last piece of the motor learning puzzle that serves as a guideline to help identify, recognize, and understand the factors that should be considered before and during its implementation.

Several years ago during the initial use and introduction of video, questions arose from educators and coaches alike about which factors or variables were the most crucial in effectively using video technology. Aspects such as gender, age, skill level of the student, the type of instruction given to the student, and the task used with the video were thought to play a vital role in helping students reap the benefits from the visual feedback video provided (Rothstein & Arnold, 1976). Nevertheless, Rothstein & Arnold (1976) found through the analyses of numerous studies, as well as the results of their own study, conflicting evidence with the current school of thought. Rather than the above-mentioned factors significantly affecting the use of video, they found that the skill level of the student, the treatment conditions administered during the study, and the length of time video was used were vital in determining the effectiveness of videotape replay (Rothstein & Arnold, 1976).

For the physical educator, this means that knowing how well students execute the skill and recognizing the students' level of proficiency will help to identify the manner in which video should be used. Research (Rothstein & Arnold, 1976; Rothstein, 1980) has pointed out that all beginners need to be guided, either by a teacher or coach, when viewing a videotape replay since they are still getting the idea of the movement (Gentile, 1972) and having trouble piecing together all of the motor skill information. This guidance will aid the students in understanding and identifying the pertinent information. After this period of time, students will possess the necessary framework to begin executing the skill with more consistency and proficiency. For those students who are already at the intermediate/advanced skill level, results suggest that videotape replay does aid in learning, but the students do not require as much of the teacher's assistance in recognizing pertinent information (Rothstein & Arnold, 1976). This coincides with the results found concerning self-regulated learning (Janelle, Kim, & Singer, 1995; Hardy & Nelson, 1988; Holt, 1982; Schneider & Pressley, 1989; Seigler, 1991; Zimmerman, 1989). By allowing students some control over the learning process and the feedback they receive, they have a greater potential for learning and retaining the information. In conjunction with these findings, Rothstein and Arnold (1976) also found that in order to derive a significant benefit from video, students, regardless of their skill level, must be exposed to the use of video a minimum of five weeks. Knowing this, physical educators can estimate and plan when and how long to use video in their classes.

Together with the factors reported by Rothstein and Arnold (1976), current research literature has offered several implications to further aid physical educators in their decision to utilize video. Through a meta-analysis of numerous studies dealing with general and visual feedback, Tenenbaum and Shaw (1993) began their discussion by re-visiting the characteristics required to make generic feedback effective in learning. They state that

> it is not sufficient to merely provide feedback to enhance performance, rather it must be a) provided after appropriate instruction… b) from a consistent and reliable source that the performer believes in and is dependent upon… c) both relevant and specific… d) preferably concurrent, [and] on-going… (Tenenbaum & Shaw, 1993, p. 60).

Before using video, physical educators need to be conscientious of these generic factors involved with giving feedback. If these concepts already exist and are being implemented in their physical education classes, then the transition toward combining verbal and visual feedback will be much smoother and possibly more effective.

Another point that was brought out emphasized the necessity for combining other modes of feedback with the visual information provided by video (Tenenbaum & Shaw, 1993). Through the combination of visual and verbal feedback, it has been reported that the information received by the learner is more meaningful and that the learner gains a better sense of identifying pertinent information related to correcting and performing the motor skill (Tenenbaum & Shaw, 1993). What this means for physical education classes is that utilizing only one type of feedback is not sufficient. Melville (1983) adds to this by recognizing the importance and value of verbal feedback, but cautions that using only verbal feedback is not highly effective, especially with larger classes. If video is to be implemented, physical educators must resist the temptation to solely rely on this medium for providing feedback. Physical educators, when contemplating the use of video, must recognize that moving from one extreme (i.e. all verbal feedback) to the other (i.e. all visual feedback) provides no real enhancement to learning. As pointed out, there needs to be a fusion of the various types of feedback in order to significantly enhance and benefit students and the learning environment.

Implementing Video Within Physical Education Classes

In light of these factors, some final thoughts and guidelines identified in the research regarding the effective use of video stem from the concepts surrounding the stages of learning students pass through when acquiring motor skills. By realizing and understanding the various stages in the learning process, physical educators can use and implement video at a level that is conducive to the learning stage of their students. Darden and Shimon (2000) addressed this issue and in so doing, discussed three stages of learning that help lay the foundation for using video.

During the first stage or beginning stage as termed by Fitts and Posner (1967), learners are primarily trying to understand the movement, what it involves, and how to coordinate their bodies to produce the movement. Still getting the idea of the movement as Gentile (1972) described, learners in this stage are very inconsistent with their performance and typically produce major errors when executing the movement (Fitts & Posner, 1967). For students who appear to be in the first stage of learning, it is suggested that video be used as more of a motivational tool to increase the desire for learning (Darden & Shimon, 2000). Since the learner is bombarded with all of the new information inherent with the motor skill and is still struggling to put it altogether, video would invite them to see themselves perform the skill in a non-threatening and non-pressured manner. By introducing video in this manner, students will gradually become acclimated to its presence and eventually see the value in its use.

The second stage or associative phase (Fitts & Posner, 1967) is characterized by an increased competency in the skill, although total proficiency has not been reached yet. Students in the associative phase can better identify the pertinent information related to the skill and seem to focus more on the skill itself rather than trying to figure out which motor pattern is needed to produce the skill. Based on other reports (Boyce, Markos, Jenkins, & Loftus, 1996; Herbert & Landin, 1997; Magill, 1998), it would appear that students in this stage would benefit more by viewing the video of their skill execution and then receiving either written or verbal cues from the instructor. Within this stage, students must be assisted in analyzing and critiquing their movement. Through these verbal and/or written cues, the students' focus is drawn to the necessary components they are lacking in, thereby paving the way for them to advance to the final stage of learning.

Lastly, in the final stage or autonomous phase (Fitts & Posner, 1967), students have become more proficient with the skill and have achieved more consistent executions. Along with the increased skill proficiency, learners are able to identify and correct many of the errors they make during their performance. To effectively implement video with students in this stage, the teacher must relinquish control of some of the learning and place it in the hands of the students. Rather than being led or directed by the teacher when viewing the video of motor skill performances, students need the opportunity to view, critique, and analyze their own movement. This does not imply that teacher feedback or cueing is not required, in fact guidance by the teacher is still necessary. However, teacher guidance and feedback should only be given after it has been sought out by the student. Interrupting students in this phase with teacher-imposed feedback degrades the effectiveness of video, thereby resulting in a lower level of learning and retention. Once again, similar to other research results (Rothstein & Arnold, 1976; Tenenbaum & Shaw, 1993), students within this phase reflect those factors associated with self-regulated learning (Janelle, et.al 1997). Allowing students to control the amount of feedback and viewing they receive, gives them the opportunity to problem-solve and analyze without the assistance of the teacher. Gradually, students learn and retain the information better when allowed to regulate some of their learning.

Once these implications have been considered and it appears that video would provide a sound and supplemental approach to learning, a few final and practical suggestions can be found to help coordinate its implementation. First, using video requires that teachers train students in the use and care of the equipment. With present day students, technology is not foreign to many and quite possibly, many students may welcome the use of something different in their classes. So, the issue of training and helping students learn to use the equipment may not require as much time as it may have five or ten years ago. Secondly, after training students to use the equipment, it seems that one of the best ways to combine video with instruction is through the use of stations. With stations, there are fewer students using the equipment at one time, which translates into more viewing and analyzing time for each student. Furthermore, students can be taught what to do and how to function at the video station, thereby freeing the teacher to provide feedback and skill analysis to other students in the class. Thirdly, a video station could provide another view and example of the correct, model performance. This would prevent the instructor from having to repeatedly show the students what the movement should look like. Lastly, at a station, students could have all of the written and visual information posted on a wall next to the video monitor or lying next to the video equipment. The station approach allows for every piece of information the teacher wants the students to utilize to be close at hand and in one specific area. By creating this area, students have a greater chance of viewing the video and finding the answer to their own question before seeking out the instructor. As a result, it helps to promote self-analysis and problem-solving skills.

Summary

As evidenced in the literature, the use of video has provided an additional, yet significant piece of the motor learning puzzle by serving as a tool to aid both physical educators and students. Along with the enhancements video can provide in the physical and cognitive domains, it also has the potential to enhance various aspects within the affective domain as well. Twenty to thirty years ago, student motivation and interest in participating was fairly high. Techniques and strategies prevalent during that time enabled educators to maintain student interest in physical activity and promote the various factors involved in learning motor skills. Unfortunately, over the past decade, while educational theories have remained for the most part unchanged, student motivation, interest, and desire to actively participate has declined. Boredom, decreased motivation, apathy, and low interest seem to plague many students in today's schools. Realistically speaking, having to compete with new and exciting technologies like video games, computers, and the World Wide Web is no easy task. So many times students would rather sit in front of a monitor or television screen and soak up the entertainment provided to them than listen to a teacher and actually physically exert themselves. With this in mind, rather than continue fighting a losing battle against technology, educators have the opportunity to embrace technology and utilize it as a resource to combat boredom and low motivation.

With all of the information, research, and factors surrounding the use of video, it may appear overwhelming or seem too difficult to use in physical education classes. However, many of the principles and concepts that make video effective are some of the same ones that should already be present. Verbal and written feedback, supervised and frequent practice and skill modeling are a few general characteristics that should be common in any physical education class. By intertwining good teaching practices with an alternative method of feedback and instruction such as video, the potential to increase interest, motivation, and most of all learning, rises dramatically. Because of the increased learning potential of video and the enhancements it can provide in the learning environment, the decision to utilize this as a viable and effective teaching tool must not be overlooked.

Statement of the Problem

The major focus of this study was to examine the effectiveness of digital video feedback during the acquisition of motor skills in middle school physical education students. The study examined if the use of digital video feedback enhanced the levels of motivation and interest when used in the physical education environment. For this study, the focal point was directed toward students that were currently in the beginning or associative stages of learning as discussed previously in this chapter.

Hypotheses and Research Questions

H_1: The mean performance score of the video intervention will be greater than the mean performance score of either the traditional or verbal intervention for both the post-test and retention test.

H_2: The mean performance score of the females in the video intervention will be greater than the mean performance score of the males in the video intervention for both the post-test and retention test.

RQ_1: What will be the perception of the students toward the use of the digital camera and laptop computer?

RQ_2: After having the opportunity to see themselves on the digital video playback, will the students feel that it helped them understand the goal of the movement?

RQ_3: Will the use of the digital camera, laptop computer, and checklist help the students analyze their performance?

RQ_4: Will the use of video feedback increase students' motivation to learn?

Instrumentation

To address H_1, a post-performance score was obtained at the end of the five-week period for each participant. To obtain this score, each student performed four soccer juggling trials. The mean of these four trials then determined the post-performance score for each student. Once a post-performance score was calculated for each subject, a mean score was then calculated for each intervention (video, traditional, & verbal). The same procedure was also used to calculate a mean performance score for each intervention on the retention test. To determine if a significant difference existed between interventions for both the post-performance test and retention test, two separate one-way ANOVA's ($p < .05$), each with a 1 x 3 design, were used to compare the means.

The second hypothesis, H_2, was analyzed using a repeated measures ANOVA ($p < .05$) with a 3 x 2 design to compare the mean post-performance scores of the males and females within the video intervention.

The research questions RQ_1 through RQ_4 were measured by the students' responses to the following questions:

RQ_1 **:** Questions 6, 7, and 8 (Appendix K)

RQ_2 **:** Question 9 (Appendix K)

RQ_3 **:** Question 10 (Appendix K)

RQ_4 **:** Question 12 (Appendix K)

After viewing answers to the various questions, the responses were analyzed and measured using content analysis. Based upon the answers given to these questions, several different categories were generated. Students' answers were then placed into one of these categories and reported accordingly.

Significance of the Study

As evidenced in the literature, innovations and enhancements in video technology have enabled educators in various content areas to provide an alternative, yet innovative means of presenting information and feedback to students. But just because this technology exists, does it necessarily mean that it would benefit physical educators and coaches in their teaching of motor skills? Research has addressed this question and has shown the effectiveness of video with professional athletes, college athletes, and higher skilled students. However, research dealing with the effectiveness of video with lower skilled students in the beginning and associative stages of learning is minimal. Knowing this, the current study explored what benefits were evident when digital video feedback was used with students who were less skilled. The current study provided some answers on how video affected the acquisition of a motor skill for lower-skilled students.

CHAPTER 2
METHODOLOGY AND PROCEDURES

Participants

Students (n=73) from three 8th grade physical education classes chose to participate in this study. Class A (n=28), Class B (n=24), and Class C (n=21) were comprised of students with various cultural and ethnic backgrounds and socioeconomic status. Each class period was scheduled to meet for 50 minutes a day, five times per week. However, after the teacher conducted the daily routines such as dressing-out and dressing-in, taking role, and warming-up, the actual activity time varied between 25 and 30 minutes. The study took place at a public school in Florida located in Leon County. Each participant involved in the study exhibited characteristics from either the beginning or associative stages of learning as defined by Fitts and Posner (1967).

The teacher participating in this study was a 25-year-old female with three years of teaching experience. She coached volleyball, basketball, and flag football at the school and did not teach any other subject other than physical education.

Skill Selection

As is the case with any study conducted in the field, it was necessary to minimize, as much as possible, any disruption that could occur to the daily operations of the teacher. For this reason, the skill of soccer juggling was selected as the skill to be used in the study. While a plethora of other skills could have been chosen for the current study, soccer juggling required very little equipment, space, and time to test and perform. With these factors in mind, soccer juggling would not impede or cause major interruptions to the teacher's instruction or classes. In the literature, a variety of other skills (Cooper & Rothstein, 1981; Del Rey, 1971; Penman, Bartz, & Davis, 1968; Rikli & Smith, 1980; Rothstein & Arnold, 1976; Sim & Stewart, 1984; Vickrey, 1980) have been used in conjunction with videotape replay. However, the advantage that many of these studies had rested in the fact that they were either conducted in a controlled setting or there was enough time for the principal investigator, coach, or instructor to sit down and provide feedback during the playback of the skill execution. The students or athletes in these studies had the luxury of ample time, plenty of equipment, and the opportunity to examine their skill performance with an instructor or coach in a one-on-one situation. Unfortunately, not all teachers and students in the field have this luxury. As mentioned earlier in the literature review, many problems like time, overcrowded classes, and minimal equipment plague teachers daily. Because the focus of this study was geared toward physical educators and students within everyday school settings, utilizing a skill like soccer juggling would cause minimal disruption to the everyday routines and activities conducted by the teacher.

Unlike other more complex motor skills, soccer juggling also provided a good challenge for the participants to practice and execute, but it was not so difficult for them to attain a reasonable amount of success within the time frame of the study. More complex skills like the tennis serve and golf swing are good skills to use with video feedback, but the environment in which they are to be used and the time allotted for learning the skill must be considered. As evidenced in the literature, video can serve as a valuable supplement to verbal feedback (Darden & Shimon, 2000; Tenenbaum, 1993) and can play an important role in motor skill acquisition at any level of difficulty (Melville, 1983; Mohnsen & Thompson, 1997; Rikli & Smith, 1980). Nevertheless, more complex skills do require additional amounts of individual instruction, precise feedback from an instructor or coach, and a longer time frame to be successful. Teachers out in the field are not always fortunate enough to give the extra attention and time necessary for skills of that nature. This is one reason the current study focused on the ability of the students, and not the teacher, to practice, execute, record, and analyze the motor skill. By empowering students to learn and analyze their motor skills more independently through the use of digital video, it was a goal of this study to determine if digital video feedback could possibly serve as a tool to help supplement instruction and help physical educators in their endeavor to teach motor skills.

Obtaining Permission

Prior to conducting this study, authorization was obtained from the director of research and the participating physical education teacher at the school. Permission was also obtained from the Florida State University Institutional Review Board.

Because the students participating were minors, a written consent form from the legal parent/guardian was obtained along with a verbal assent from the student . Several weeks before data was collected, the principal investigator met with the physical education teacher to determine the most efficient method of distributing and collecting the necessary permission from both the parents and students.

Time Frame of the Study

In the literature (Rothstein & Arnold, 1976), it has been suggested that video should be used a minimum of five weeks in order to see any significant benefits. Unfortunately, there is no consistent or specific time frame mentioned in the literature regarding when, how often, and how long each exposure to video should be conducted. With this in mind, the duration of the current study was five weeks with a two-week delayed retention test. The students met in their regularly scheduled physical education classes five days per week for 50 minutes per day. The actual timeline of the study and the events involved are stated in Appendix A.

Assigning Students to an Intervention

During the first two days of class, students were dismissed in groups of four to go over to the principal investigator. After practicing for one minute, students received four trials to juggle the soccer ball as many times as they could using their feet. Students were instructed that they could use any body part, excluding the hands and arms, to keep the ball in the air, but that only foot contacts would be counted toward their score. The principal investigator then recorded all four trials and calculated each students' intervention assignment score (IAS) by taking the mean of those four trials (Appendix B).

Based upon their IAS, each student was ranked and randomly placed into the traditional (T), verbal (VB), or video feedback (V) intervention. Students having an IAS of 0-5 or 6-12 were classified as low skilled and medium skilled respectively. Other students having an IAS of 13 or more were classified as high skilled and were not assigned to an intervention. These students were no longer a part of the study since the focus was to determine the effectiveness of video with students who were in the beginning or associative stages of learning. Using a paired assignment method, the principal investigator started with the highest-ranking score and placed the student with that score into the T intervention. Moving to the second highest score, the principal investigator placed that student into the VB intervention. The individual with the third highest score was then placed into the V intervention. The principal investigator then moved consecutively down the scores from highest to lowest assigning students to an intervention in this same fashion until everyone had been placed into either the T, VB, or V intervention. This paired subject assignment method of placement ensured a more even distribution between the interventions.

Task Manipulation

The traditional intervention received 1 minute and 30 seconds to practice juggling and to view a model performance. After practicing, students in the traditional intervention (T) performed four trials for the principal investigator. The principal investigator counted and wrote down their scores and then had them fill out the remainder of the checklist. The T intervention did not digitally record any of their skill performances nor did they view any type of video feedback about their performances. Once they performed their four trials for the principal investigator and filled out the checklist, they returned to class with the other students.

Those students placed in the video intervention (V) also received 1 minute and 30 seconds to practice juggling and view a model performance. Once they finished practicing, students in the V intervention performed two trials and digitally recorded them. These two trials were then viewed on a laptop computer at their own pace. Once the students viewed their two recorded trials on the laptop, they performed two more trials. This allowed the students an opportunity to correct any mistakes they may have found in their performances. After completing a total of four trials, the V intervention students filled out the remainder of the checklist and returned to class.

The verbal intervention (VB) received 1 minute and 30 seconds to practice juggling. This group did not view a model performance nor did they digitally record any of their performances. After practicing, the VB intervention performed four trials and then filled out the remainder of the checklist. Students in the VB intervention then returned with the rest of the class.

Training the Students

After each student had been assigned to an intervention, students commenced their training on the equipment that pertained to their group. Students in the V intervention were instructed on how to use the Sony Mavica MVC-FD100 digital camera. They were able to practice taking videos and were able to familiarize themselves with the digital camera. Students were then taught how to transfer the video they captured to a Dell Latitude laptop computer. Once the video was transferred to the computer, students were also be shown how to view their video at full speed and frame-by-frame using the Quick-Time video software.

Along with training on the use of the equipment, students in the V intervention were also trained during this time on how to score a skill performance. A correct model was shown of soccer juggling in conjunction with several other juggling examples. The principal investigator once again reminded the students that only foot contacts were counted in the scoring of their performance. The ball could be kept in the air using other body parts, excluding the hands and arms, but only contacts made by either foot would be counted. Students became familiar with the checklist that was at the video station and practiced using it as well.

Those assigned to the T intervention were trained on how to use the laptop computer since they would be able to view a performance model. However, the T intervention would not be trained on using the digital camera since they would not be recording their performances. Those in the VB intervention would not be trained on the use of any electronic equipment since they would not be recording their skill performances or viewing a performance model. Both the T and VB intervention did receive training on how to score their performances and use the checklist.

Data Collection

Upon entering class each day, the physical education teacher conducted her usual routines for starting class. Once these procedures were taken care of, the physical education teacher was given a list of students that needed to be dismissed to participate in the study. At the teacher's discretion, she dismissed four to six students at one time to come over to the video station. Each group of students dismissed to go over to the principal investigator contained either all T, VB, or V intervention students. When dismissed, the T group students went over to the principal investigator, picked up a checklist, viewed the performance model, and began practicing juggling the soccer ball. After 1 minute and 30 seconds of practicing, each student then had four trials to juggle the soccer ball as many times as they could. After each trial, the principal investigator recorded the number of foot contacts they made. Each student then filled out the remainder of his/her checklist, handed it back to the principal investigator, and returned to class with the physical education teacher. Appendix C shows a diagram of the in-class rotation for the T intervention.

Students in the VB intervention went over to the principal investigator, picked up a checklist, and then began practicing juggling. Students in this intervention however, did not view a model performance like the T and V interventions. After 1 minute and 30 seconds of practicing, each student had four trials to juggle the soccer ball as many times as they could. After completing each trial, the principal investigator recorded the number of foot contacts made. When finished with their trials, each student filled out the remainder of his/her checklist, handed it back to the principal investigator, and went back with the rest of the class. Appendix D shows a diagram of the in-class rotation for the VB intervention.

Those in the V intervention went over to the principal investigator, picked up a checklist, and then began practicing juggling the soccer ball. These students had the opportunity to view a model performance at this time as well. After 1 minute and 30 seconds of practicing, two of the students in the group went over to the digital camera. The students digitally recorded each other performing two trials of juggling the soccer ball. Once done with recording two trials, the next pair of students proceeded in recording their two trials. As each student in the group recorded two trials, he/she then removed the memory card from the digital camera, took it over to the laptop, and viewed the video of his/her performances. While viewing their performances, students also had a correct model of soccer juggling available to them on the laptop. After reviewing the videos on the laptop and having the principal investigator score the first two trials, students then performed two more trials. This was done so that students had an opportunity to see their mistakes from the video and correct them for the last two trials. The final two trials were not digitally recorded. After completing these final trials, students filled out the remainder of the checklist, returned it to the principal investigator, and went back with the rest of class. In all, the V intervention attempted and recorded a total of four trials just like the T and VB interventions. The only difference was that the V intervention had two trials before viewing their performances on video and two trials after viewing their performances. Appendix E shows a diagram of the in-class rotation for the V intervention. Appendix F, G, and H contain the checklists that the T, VB, and V interventions used to help them with their performances.

To help control for other factors like students practicing outside of class and competition between students, participants were encouraged to do their best and attempt to better their own juggling skills rather than compare their scores. No juggling records were displayed nor were students encouraged to practice outside of class.

Post-Test Performance and Survey

The final two days of the study were reserved for a skill post-test that was administered to every participant (Appendix I). Students were dismissed in groups of four to six to come over to the principal investigator. The students had one minute to practice and were then given four trials to juggle the soccer ball as many times as they could. They were also reminded that only foot contacts counted toward their score. A post-performance score (PPS) was then obtained for each student by taking the mean of the four trials. Although no specific soccer juggling test was found in the literature with a proven validity, the post-test administered to the students was devised and discussed with two outside individuals who possessed extensive expertise and coaching experience with the sport of soccer. Along with the principal investigator and his experience in coaching and playing soccer, it was agreed upon by all three individuals that this post-test was a valid measure for indicating the level of skill with soccer juggling.

As soon as students completed their skill post-test, the principal investigator recorded their scores and asked the students in the T and V interventions to fill out a questionnaire (Appendix J & K). Once students filled out the questionnaire, they went back with the rest of the class. During this time, the physical education teacher was also asked to fill out a questionnaire (Appendix L) and return it to the principal investigator. Two weeks after the post-test had been conducted, the principal investigator returned to the school and administered the retention test. For this test, students repeated the same procedures mentioned above with the exception of filling out a questionnaire.

Equipment

Since the study focused on video and how it could benefit physical education teachers and their students, the equipment used in the study was chosen for its affordability, durability, ease of use, and quality. First of all, the students used the Sony Mavica MVC-FD100 series digital video camera to record their skill performances. The camera has the ability to take still pictures as well as, five, ten, or fifteen-second video clips. The quality of the still pictures and the video are very good and are comparable to other higher-end, more expensive digital cameras. The still pictures or video can be directly recorded to either a 3.5" floppy disk or to a memory stick. Because of its storage space, durable construction, and faster read time, a 32 megabyte and 64 megabyte memory stick manufactured by Lexar, Inc. was used to transfer the students' videos from the camera to the laptop computer. The camera was mounted on a 72” Ambico tripod.

After the students took the memory stick out of the camera, they took it over to a Dell Latitude CPt series laptop computer. Attached to the computer by a USB cable was a memory stick reader manufactured by PNY Technologies. The laptop computer had 128 megabytes of RAM (random access memory), a 600 MhZ Intel Celeron processor, and used the Microsoft Windows Millenium Edition operating system. This laptop was part of the educational series computers offered through the Dell Corporation and was considered a low-end, but very functional, durable and useful laptop. By current standards, it was not as powerful or as fast as higher-end machines, but it did provide a good quality and stable platform to work with.

Finally, the software that was used to open and view the videos on the laptop computer was QuickTime Pro 6.5. This video software allowed students the benefit of seeing their performance videos either in full speed, slow speed, or frame-by-fame. The interface is very user friendly and can easily be purchased and downloaded through Apple Computing on the World Wide Web.

CHAPTER 3
RESULTS

Introduction

This chapter examines the data obtained throughout the course of the study and addresses the results for each hypothesis and research question independently. Hypothesis one stated that the mean performance score of the video intervention will be greater than the mean performance score of either the traditional or verbal intervention for both the post-test and retention test. Data pertaining to hypothesis one were analyzed using two separate one-way ANOVA's each with a 1 x 3 design. For one analysis, the mean post-performance test score was used as the dependent factor while the intervention (video, traditional, and verbal) was used as the independent factor. The other analysis used the mean retention test score as the dependent factor while the intervention (video, traditional, verbal) was used as the independent factor. Both ANOVA's were conducted using a 95% confidence interval level.

Hypothesis two stated that the mean performance score of the females in the video intervention will be greater than the mean performance score of the males in the video intervention for both the post-test and retention test. Data pertaining to hypothesis two were analyzed using a repeated measures ANOVA with a 3 x 2 design. Time (intervention assignment test, post-test, and retention test) was used as the within-subject factor while gender (male and female) was used as the between-subject factor. The repeated measures ANOVA was conducted using a 95% confidence interval level.

Upon completion of the study, surveys were given to the students in the video intervention to determine their thoughts and feelings toward the use of technology. Because of the qualitative and open-ended nature of the questions, the data were analyzed by placing the students' answers to the survey questions into various categories that defined their overall feelings/thoughts. Conclusions could then be drawn from these categories.

Descriptive statistics about the students, classes, and interventions are presented in Table 1.

Table 1

Descriptive Statistics of Students, Classes, and Interventions

	n	*M*	*SD*
Age in yrs.			
Males	36	13.33	.48
Females	37	13.14	.42
Total	73	13.23	.46
Class Size			
Class A	28		
Class B	24		
Class C	21		
Video Intervention			
Males	13		
Females	11		
Traditional Intervention			
Males	12		
Females	13		
Verbal Intervention			
Males	11		
Females	13		

Hypotheses

H_1.

Hypothesis one stated that the mean performance score of the video intervention will be greater than the mean performance score of either the traditional or verbal intervention for both the post-test and retention test. Table 2, which presents the ANOVA results, reveals that for both the post-performance test and the retention test, no significant differences were evident. Based on these results, all three groups were similar in their soccer juggling performance immediately after the study and two weeks later during the retention test. These results indicate that the use of digital video feedback with this particular skill and grade level did not prove any more beneficial than the other methods utilized in this study. Because no significant differences were obtained, hypothesis one was rejected.

Table 2
ANOVA of Mean Performance Scores Across Intervention

Source	*M*	*SD*	*df*	*F*	*p*
Post-performance test	2.81[a] 2.75[b] 2.57[c]	1.34 1.09 1.40	2	.23	.80
Retention test	2.88[a] 2.80[b] 2.54[c]	1.60 1.50 1.16	2	.36	.70

[a]video. [b]traditional. [c]verbal. $^*p < .05$.

H_2.

Hypothesis two stated that the mean performance score of the females in the video intervention will be greater than the mean performance score of the males in the video intervention for both the post-test and retention test. As shown in Table 3, significance was obtained for both the gender effect and the time effect. The results for the gender effect indicated that overall, males performed better than the females in the video intervention (see Figure 1).

Table 3

Repeated Measures ANOVA for the Video Intervention Using Time as a Within-Subject Factor and Gender as a Between-Subject Factor

Effect	*Wilk's λ*	*F*	*df*	*p*	η^2
Gender	-	11.72	1, 22	.00*	.35
Time	.71	4.24	2, 21	.03*	.29
Time by Gender	.87	1.56	2, 21	.23	.13

$^*p < .05$.

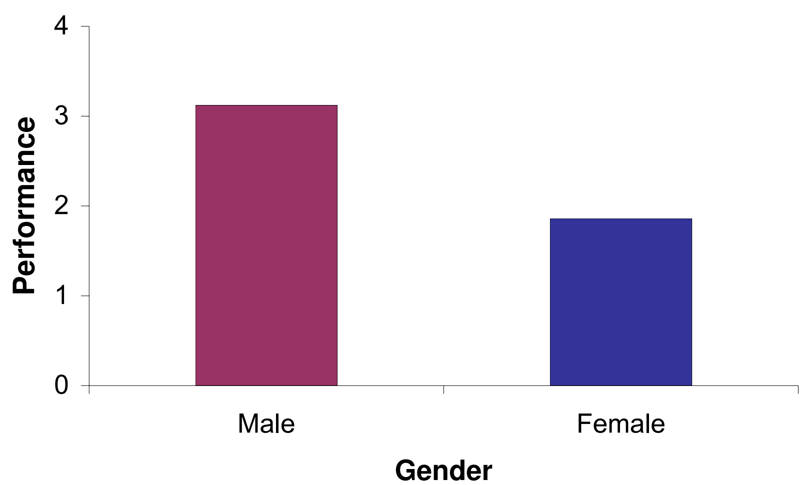


Figure 1. Performance Means of Males and Females in the Video Intervention.

The same situation existed for the time effect in Table 3. Throughout the duration of the study, students in the video group significantly improved their performance (see Figure 2). Though significance was found, the time effect considered everyone in the video group without taking into account the gender of the student.

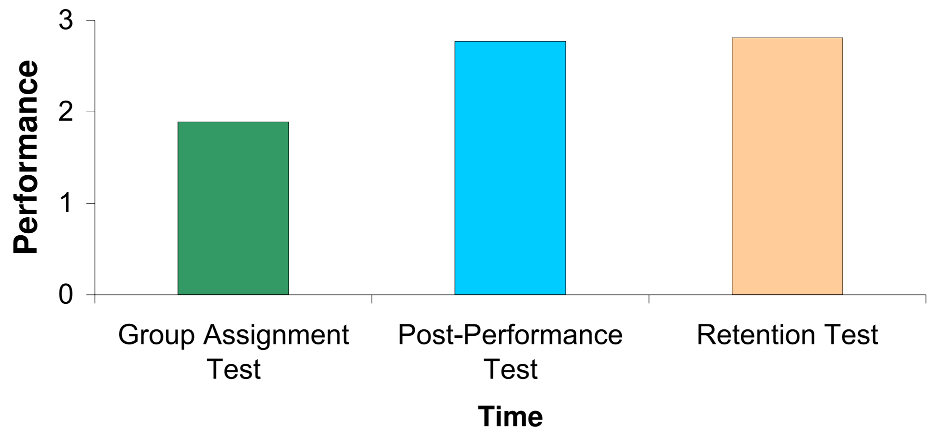


Figure 2. Performance Means of the Video Intervention Across Time.

Because it accounted for both time and gender interaction effects, the time by gender effect was used to address hypothesis two. In Table 3, the time by gender effect revealed no significant difference thereby indicating that males and females in the video intervention had similar performance and improvement across the time frame of the study (for more detail, see Figure 3). Based on this finding, hypothesis two was rejected.

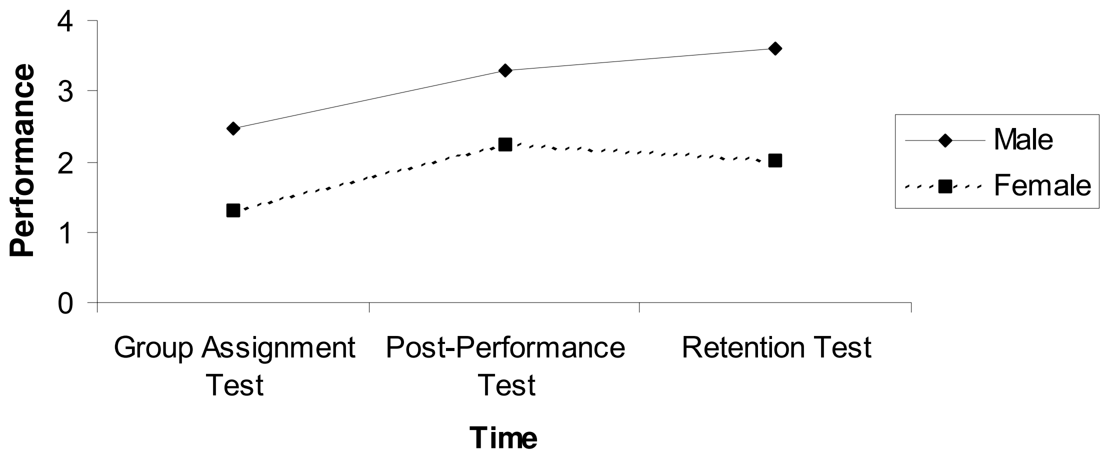


Figure 3. Performance Means of the Video Intervention Across Time and By Gender.

Research Questions

RQ_1.

Research question one asked, "What will be the perception of the students toward the use of the digital camera and laptop computer?" To derive the students' thoughts and perceptions, questions 6-8 from the student survey (Appendix K) were used to develop the various response categories. There were 24 students in the video group and of those students, 71% stated they liked using the digital camera and computer while 29% did not. The results for the students' perceptions of using the digital camera and computer can be seen in Tables 4 and 5.

Table 4

Why Students Liked Using the Digital Camera and Computer[a]

Reason	*Percentage*
They liked technology/electronics	34%
It was fun/enjoyable	29%
They could watch for their mistakes	8%

[a]n = 24.

Table 5

Why Students Did Not Like Using the Digital Camera and Computer[a]

Reason	*Percentage*
It took too long to use/It took up too much time	21%
It was too repetitive	8%

[a]n = 24.

RQ_2.

Research question two asked, "After having the opportunity to see themselves on the digital video playback, will the students feel that it helped them understand the goal of the movement?" To derive the students' thoughts and perceptions, question 9 from the student survey (Appendix K) was used to develop the various response categories. There were 24 students in the video group and of those students, 62% stated that seeing themselves on the video playback helped them understand the goal of the movement while 38% felt it did not help them. The results for the students' perceptions of why they felt it was helpful and why they did not feel it was helpful in understanding the goal of the movement can be seen in Tables 6 and 7 respectively.

Table 6

Students' Perceptions of Why the Digital Video Playback Was Helpful in Understanding the Goal of the Movmement[a]

Reason	*Percentage*
They could see what they were doing wrong/They could see what to correct	62%

[a]n = 24.

Table 7

Students' Perceptions of Why the Digital Video Playback Was Not Helpful in Understanding the Goal of the Movmement[a]

Reason	*Percentage*
They could not see, notice, or feel their mistakes	13%
They did not see any improvement	13%
They felt it did not belong in P.E.	8%
They already knew what was wrong with their performance	4%

[a]n = 24.

RQ$_3$.

Research question three asked, "Will the use of the digital camera, laptop computer, and checklist help the students analyze their performance?" To derive the students' thoughts and perceptions, question 10 from the student survey (Appendix K) was used to develop the various categories. There were 24 students in the video group and of those students, 63% felt that using the digital video equipment and the checklist helped them analyze their performance while 37% did not. The results for students' perceptions of how the use of the equipment and the checklist helped or did not help them analyze their movement can be seen in Tables 8 and 9 respectively.

Table 8

Students' Perceptions of How Using the Digital Video Equipment and Written Checklist Helped Them Analyze Their Movement[a]

Reason	*Percentage*
They could actually see and critique their own performance	13%
They could tell what needed to be worked on/practiced	29%
They could see their improvement	4%
Did not know-Just felt that using everything helped	17%

[a]n = 24.

Table 9

Students' Perceptions of How Using the Digital Video Equipment and Written Checklist Did Not Help Them Analyze Their Movement[a]

Reason	*Percentage*
They could not feel their mistakes	8%
They found out on their own what was wrong	8%
They could not see their improvement	4%
Did not know-Just felt that using everything did not help	17%

[a]n = 24.

RQ_4.

Research question four asked, "Will the use of video feedback increase students' motivation to learn?" To derive the students' thoughts and perceptions, question 12 from the student survey (Appendix K) was used to develop the various response categories. There were 24 students in the video group and of those students, 29% felt that the use of digital video feedback increased their motivation to learn the skill while 71% felt it did not. The results for the students' perceptions of how digital video did or did not motivate them to learn the skill can be seen in Tables 10 and 11 respectively.

Table 10

Students' Perceptions of Why Digital Video Feedback Increased Their Motivation to Learn the Skill[a]

Reason	*Percentage*
They could see what they were doing wrong	17%
They could see their improvement	4%
They liked using technology/electronics	4%
Did not know-Just felt that using it motivated them	4%

[a]n = 24.

Table 11

Students' Perceptions of Why Digital Video Feedback Did Not Increase Their Motivation to Learn the Skill[a]

Reason	*Percentage*
They did not like using technology/electronics	8%
They did not like seeing themselves perform something wrong	4%
They were already interested/motivated to learn the skill	4%
They did not like the sport it was being used with	17%
They felt it took up too much time	4%
Did not know-Just felt that using it did not motivate them	34%

[a]n = 24.

CHAPTER 4
DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The purpose of the current study was to examine the effectiveness of using digital video feedback with middle school physical education students during the development and acquisition of a motor skill. As discussed in chapter one, the literature provides evidence that the use of video, when combined with good teaching practices, has the potential to enhance learning in different environments and with different grade levels. However, because the field of physical education and the realm in which it is taught encompasses so many variables like teaching experience, skill level of the student, class size, skill complexity, and sport specificity, and since there is very little research focusing on video in physical education, solid conclusions as to the overall success of video for each physical education teacher and their specific situation have not been drawn. With that being said, the findings for this study may help to establish a framework for future research and provide some interesting thoughts and insights that may serve as a starting point for physical educators interested in pursuing an alternative method of motivating and teaching motor skills to students.

Hypotheses

H_1.

Evidence in the literature identified visual feedback as a vital component during the initial stages of understanding and performing motor skills (Adams, Gopher, & Lintern, 1977; Rikli & Smith, 1980; Rothstein, 1980; Schmidt & Wrisberg, 1973). Since video provides visual feedback and allows students the freedom to view motor skills at their own pace and piece together how a movement is executed in a slower, more controlled fashion, it would appear that video feedback could enhance learning. Literature has also shown that when students are given some control over the amount of feedback they receive, they show improvement in both their learning and performance (Janelle, Kim, & Singer, 1995; Schneider & Pressley, 1989; Seigler, 1991).

When these factors are coupled together with the motivational aspects inherent in video feedback, it has the potential to produce a richer learning environment. Based upon this evidence, it was hypothesized that those students in the video intervention would perform better than those in the traditional and verbal intervention for both the post-test and retention test. The results obtained for this first hypothesis indicated otherwise (see Table 2).

Because physical education teachers already have numerous responsibilities and activities to attend to throughout each class period, it was a goal of the current study to determine if students could analyze their motor skill performance without the constant assistance and feedback of the teacher. This was done to allow students an opportunity to critically think and problem solve, but more importantly, it was an opportunity to examine if digital video feedback could provide a more self-contained form of feedback that could be used in conjunction with teacher feedback. In the literature, Gentile (1972) points out that "getting the idea of the movement" or the beginning stage as defined by Fitts and Posner (1967), is the first stage all learners must pass through on their way to acquiring a motor skill. Focusing on the mechanics of the movement and distinguishing between relevant and non-relevant information about the movement are factors that primarily concern learners during this stage. Since the participants in the current study were in this beginning stage of learning with the skill of soccer juggling, the wealth of information provided by the video feedback may have been too overwhelming for the students to handle. Research has indicated that although video is an important form of visual feedback, there still needs to be some guidance for beginners when they are viewing their performances and trying to point out and fix mistakes (Darden & Shimon, 2000; Kernodle & Carlton, 1992; Magill, 1998; Melville, 1983; Schmidt, 1988). Along these same lines, video playback may present valuable information about the movement, but it does not always present every piece of information critical to improving performance (Magill, 1998). When using video feedback, the information to correct mistakes may be evident in the performance video, but because the learner's focus is divided between the basic mechanics of the skill and the visual information presented in the playback, the learner does not know which details to pay attention to. For the current study, this may have contributed to the lack of difference in performance between the video intervention and the other interventions. Students may have been overwhelmed with the information transmitted through the video and since no guidance by an instructor was provided, may have become frustrated with the movement.

Rather than exclude beginners altogether from using digital video feedback, a way to help alleviate the frustration they may face in the absence of guidance may be to reduce the total number of cues for the movement while introducing the cues on the video one at a time to the learner. Initially, the learner was faced with processing all of the cues of the movement along with all of the information provided to them in the video playback. If the total number of cues were reduced, then it obviously would reduce the amount of information that must be processed by the learner. To help further control the amount of information presented, the cues could be introduced one-by-one using the video as a means to visualize how the cues should be performed. As time passes and the learners continue to be introduced to each of the cues, the teacher or instructor can gauge by the performance when it appears to be too much information for the learners to process. Once this performance plateau is reached, the teacher or instructor could decrease exposure to the video and help the learner better their performance through another means. By approaching the use of video from this angle, beginners may feel more comfortable with digital video feedback and may feel less overwhelmed by the information presented to them.

On the other end of the continuum, if several students were adept at performing the skill or were considered elite athletes within that particular sport, digital video could possibly be used more independently by the students. Since the students have already passed through the initial stages of learning, their focus can be taken off the sheer mechanics of the movement and placed on other cues and pieces of information that enhance either the outcome of the movement or the technique being used to achieve the outcome. While beginners are still deciphering between relevant and non-relevant information, more advanced athletes or learners are concerned with enhancing the speed and efficiency with which they execute the movement. Since the movement for more advanced learners is autonomous, they will be more likely to focus, without the guidance of an instructor, their attention on identifying their mistakes. Not only this, but they will also be able to concentrate more on game-like situations, scenarios, and tactical strategies. Because of its versatility, digital video feedback could be quickly adapted to meet the needs of more expert learners and would free up the teacher to work with students who may be at a lower skill level.

For the current study, the performance similarities between the interventions may also have been attributed to the manner in which the skill was performed. On the one hand, the skill of soccer juggling was a novel skill that many of the students had not seen or attempted before. While the skill certainly challenged the students, it was not performed within a context that emphasized why the skill was done or how it fit into a game-like situation. Students were called out from class to come over, juggle the soccer ball, and then return with the rest of the class. In the meantime, students may have been involved in a unit on volleyball, tennis, or softball. Had the students been involved in a soccer unit, the skill may have meant more to them than merely an activity to keep the ball up in the air with their feet. To help students grasp a better understanding of various skills and sports, research has offered different approaches teachers can use in physical education. One approach called the tactical games approach emphasizes the how, why, and when of performing motor skills (Bunker & Thorpe, 1982; Griffin, Mitchell, & Oslin, 1997; Werner & Almond, 1990). In essence, students understand better why a skill is done and how it relates to game play. Rather than practicing the motor skill in isolation, the tactical games approach seeks to improve the skill through game-play and tactical awareness. Perhaps if the current study was to be revisited, it may prove more advantageous and interesting to the students if they were involved in a soccer unit and if they knew the reasoning behind the skill and why it was performed.

Further speculation as to why no differences existed between the interventions may point to the specific motor skill chosen for the study. Because of the grade level being investigated, it was desirable to choose a more novel skill that challenged the students yet provided some degree of success. At the start, soccer juggling seemed to fit that profile. It also required very little equipment and was simple enough for students to quantify. Though soccer juggling was considered more novel than many other motor skills, the results suggest that it might have been too difficult for the students. Students, regardless of their intervention, only improved on average by one or two points from the start of the study to the finish. However, there was improvement nonetheless. Since all students did improve in their performance, the common thread tying these groups together was practice. Practice, as mentioned in the literature (Adams, 1971; Gentile, 1972; Magill, 1998; Schmidt, 1975, 1988), plays a vital role when acquiring motor skills. To obtain a more accurate measure of digital video feedback effectiveness for the current study, it may have been better to test a variety of simple and complex motor skills. Rather than use digital video feedback only with the skill of soccer juggling, other motor skills could have been tested to help formulate a precedence of what skills lend themselves to the use of digital video feedback. By establishing this precedence, physical educators could plan better knowing that video feedback may be more effective with certain complexities of motor skills. An answer to a question such as "Is video feedback more effective with lesser complex skills like a football throw or would it be better used with intermediate skills like the volleyball serve?" would give teachers a better gauge to go by when contemplating the use of digital video feedback. The current study only looked at one complex motor skill, but if a range of other skills were used, it would help answer the question of what type of motor skills may be better suited for video feedback.

Not only would it be beneficial to test different motor skills, but it may also prove just as helpful to note the skill levels of the students attempting the skills. In the literature, the skill level of the student was found to affect the overall success of video feedback (Rothstein & Arnold, 1976). By paying attention to the students' skill levels and allowing all skill levels to participate in the study, a clearer picture might be obtained about the skill level students need to possess in order to benefit from using video feedback. Knowing this element could help in future planning and implementation of video feedback so that it could be geared more toward the specific motor skill and skill level of the students.

Aside from physiological or motor learning factors, one of the reasons video feedback may not have been as effective in this study could have been related to the fact that it was conducted and implemented by the principal investigator rather than by the teacher. Regardless of subject matter, teachers in every classroom or gymnasium form a bond with their students. Seeing and interacting with each other day after day allows both teachers and students the opportunity to establish a good rapport. Teachers know the characteristics, personalities, nuances, and situations that surround their students. With this knowledge, teachers command a different type of respect and the students realize this. Students understand their role and relate to the teacher in a manner that no one could understand unless they were present on a day-to-day basis. Establishing a student-teacher relationship takes time and daily interaction, something that could not be done by the principal investigator for the current study. An outsider, like a researcher or substitute teacher who comes into this environment, is at a disadvantage. Not knowing students' names, being unfamiliar with the daily operations, and being seen as a "guest" at the school are all obstacles that may interfere with conducting the study within a school setting. A prime example of this occurred in the current study when substitute teachers had to be used or when classes had to be combined. In these situations, students were out of control and simple tasks like taking role and dressing out took much longer. Other unforeseen activities like practice fire drills, extracurricular clubs, athletic events, and buying physical education uniforms were just a few of the many activities that played a role during the study. Factors like these pose as obstacles to both teachers and researchers. Conducting the study in a more controlled environment like a laboratory could have minimized these disadvantages, however, the implications that could have been drawn would have been limited in their application since physical education teachers are unable to have maximum control over the students and the school environment. In the future, it may prove more beneficial to get the teacher involved, at least in some small way, during the implementation of the video feedback. Doing so may help the students realize it is something supported by the teacher and because of this support, warrants their attention and desire to do better.

From a more qualitative standpoint, the data obtained from the student surveys reveal that 13% or three of the twenty four students stated that they could not see, notice, or feel their mistakes (see Table 7). Another 13% stated that they could not see any improvement (see Table 7). These students may have benefited, as mentioned previously, from the use of digital video if they had someone to guide them and help them analyze their skill performance. Realistically, the teacher could not sit down with every student on a daily basis or discuss with each student during class about his/her performance. Nevertheless, a time set aside when time permits could allow teachers to gradually review videos with their students. Over a period of time, as the students become more and more accustomed to using video feedback and become more aware of what to look for, they could eventually start to analyze their video or even videos of other students and determine what needs to be worked on and corrected by themselves. Initially, this would take time and more effort on the part of the physical education teacher and care would have to be taken so that students are not overwhelmed with the information presented to them. But once the use of video feedback became a standard part of the class, it may provide an avenue for critical thinking and another form of feedback.

Before conducting the current study, it was logical to assume that students, especially at the middle school level, would enjoy seeing themselves on video and having the opportunity to critique their performance. Time and again, the literature supports this notion by providing evidence of increased motivation when using video in various learning environments (Bandura, 1997; Jambor & Weekes, 1995; Magill, 1998; Weeks, Brubaker, Byrt, Davis, Hamann, & Reagan, 2002). That is why it was surprising to see the decreased levels of motivation reported by the students for the current study (see Table 11). As a result of this decreased motivation, the students' performance levels may have decreased as well. An overwhelming 71% of the students in the video intervention stated that using the video feedback did not increase their motivation to learn the skill. The answers given by the students indicated that the video feedback might have been overused. During the five-week period, it was apparent that students did not remain motivated and became indifferent to its use. On a daily basis, students were pulled from class activities or games to come over and juggle the ball and view their videos. Although the principal investigator varied the time students were taken away from their activities or games, students still became frustrated not only with the skill, but also with having to miss a few minutes of their games. Based on their meta-analysis, Rothstein and Arnold (1976) found that using video with learners for at least five weeks was enough time to see a possible benefit. But throughout their analyses, no specific time limit ever proved 100% beneficial to the learners. The current study adhered to suggestions given by the literature, but was unable to find any more benefit than the other methods being implemented. Overuse, students' frustrations in trying to figure out the movement, and missing game time during class all played a role in decreasing their motivation. To combat this issue of overuse and possibly increase the effectiveness of digital video for future studies, teachers and researchers may need to control the frequency with which they use video feedback. By doing so, students may stay interested longer thereby increasing the potential for improving their performance.

After examining other aspects surrounding the use and effectiveness of digital video feedback in the current study, a final thought that may help future endeavors within this area is to consider the type of learning environment video feedback will be used. In addition to the physical stages of learning (Fitts & Posner, 1967; Gentile, 1972), research suggests that students also learn through implicit and explicit means. These types of learning have been explored in other contexts and learning environments (Green & Flowers, 1991; Hardy, Mullen, & Jones, 1996; Masters, 1992; Nissen & Bullemer, 1987; Reber, 1967; Reber & Allen, 1978) and when applied to the current study, may provide some insight on how to increase the learning potential of video feedback. Implicit learning refers to the acquisition of a skill through natural processes in which the learner is not conscious or aware of the specific details of how the skill is being learned (Maxwell, Masters, & Eves, 2000). In essence, an environment emphasizing implicit learning encourages the learner to practice and experience the skill on his/her own and to learn from his/her mistakes. The learner is allowed the opportunity to develop techniques or approaches to acquiring the skill that he/she feels comfortable with. Implicit learning allows for a more personal discovery of the skill. Opposite of implicit learning, explicit learning encourages the learner to adhere to specific rules, techniques, and verbal information provided by a source outside of the learner, typically a teacher or coach. In this environment, the learner is told or shown what is wrong with the performance by an outside observer, either through a teacher, coach, or media device, and then based on this information, modifies his/her future skill performances. With explicit learning, there is less reliance upon self-discovery and a more conscious effort to learn from the information provided.

Within the context of the current study, the learning environment seemed to encourage explicit learning. Viewing the skills checklist, answering questions about each performance and specific ways to improve, and viewing the video on a daily basis provided the participants with a good amount of information and feedback about their skill performance. While this explicit learning in the form of written and visual feedback may have seemed helpful, research has found that in some instances, learners may need a more implicit learning environment when acquiring motor skills. Green and Flowers (1991), after conducting their study using a visual tracking skill, found that participants who were in the explicit learning intervention performed poorly when compared to those in the implicit learning intervention. Using the motor skill of golf putting, Masters (1992) found that participants in the implicit learning intervention performed just as well as those in the explicit learning intervention. Though similar performance was reported, further results showed that when participants were placed under psychological stress, those in the implicit intervention improved while those in the explicit intervention did not. Implicit learning also appears to be more resistant to the effects of forgetting over time and independent of age and IQ (Allen & Reber, 1980). Other studies provide evidence of the effects implicit learning may have on performance, and in some cases, find it more beneficial than explicit learning (Boyd & Winstein, 2004; Hardy, Mullen, & Jones, 1996; Wulf & Schmidt, 1997).

Looking at the current study, regardless of the intervention students were placed, performance did improve over time. What was not so evident were the students in those interventions that started with a mean score of only 1-2 foot contacts, but by the end of the study had a mean score of 8-10 foot contacts. Learning did take place, but the cause of that learning cannot be totally attributed to the video feedback. Some students in both the traditional and verbal interventions who didn’t have this visual feedback showed these improvements in performance. Based on the evidence just presented, it appears that students in the traditional and verbal interventions may have learned the skill of soccer juggling through implicit learning. Rather than be told or watch on a daily basis the things that were wrong with their performances, those students in the traditional and verbal interventions seemed to adapt, modify, and learn the skill in a way that made sense to them. The result was improved performance. For those in the video intervention, they not only had the written checklist and model video, they also had to watch and critique their own skill performance. This means that they had to verbalize, or at least capture their thoughts, on paper and explain what they were doing and how to improve. This may have been the drawback. For an implicit learning environment, verbalizing the skill or pointing out the specific mistakes in the technique detracts from the overall goal to improve performance. What this implies for video feedback is simply to allow students the freedom to choose when to use the visual feedback or present it to them on a limited basis and allow them to decipher their own mistakes without having to verbalize or write them. Forcing students everyday to view and explain their skill performance may actually hinder their progress. Although an implicit learning environment has been shown to improve learning and performance, it does not alleviate the need for explicit learning. Verbal feedback from teachers and coaches is still a very vital necessity when it comes to teaching motor skills. It is just that sometimes all of the information and feedback students are bombarded with creates a confined atmosphere that does not allow students the opportunity to learn on their own, whether consciously or not, from their own mistakes. In the future, it would be interesting to use digital video feedback within an implicit learning environment and determine an optimum level of feedback from video that could benefit students.

H_2.

Since the first hypothesis in this study dealt strictly with the effectiveness of video feedback between types of intervention, a second hypothesis was formulated that dealt with video feedback and gender. Very little information has been found in the literature regarding this topic. But based upon different physiological principles and the method through which each gender learns, it was hypothesized that females in the video intervention would perform better than the males in the video intervention for both the post-test and retention test. As reported earlier in this paper, no significance was found between genders (see Table 3).

Both genders had the same time to practice and perform the skill as well as, the same exposure to the use of video feedback. Physiologically speaking, girls take in more sensory data than boys (Gurian & Henley, 2001) and tend to seek out more possible solutions to tasks or problems they are faced with (Blum, 1997; Gurian & Henley, 2001; Moir & Jessel, 1990). In light of this, it was thought that the females in the study might take more seriously the opportunity to view and analyze their performance. This is not to imply that the males did not take viewing their performances seriously, but rather females might have been more inclined to carefully review their performances and use that information to correct their errors. To illustrate this, after looking at the answers written on the skill checklists, female students provided much more detailed answers about their performances than did the males. The boys' answers, on the whole, did not articulate as many specifics. It was thought that boys, since they search for a more direct solution to a problem, might not have benefited from video as much as the girls. For the current study however, both genders seem to have benefited equally from the use of video feedback when it was used in this context and with this particular motor skill. Further research must be conducted in order to gain a better understanding of effects of video feedback between males and females.

Research Questions

To add further depth to the current study's results, four research questions were devised that provided some insight into the students' overall feelings, thoughts, and attitudes toward the use of technology. This qualitative data not only offered supplemental information, but also enabled the results to be examined in a more holistic manner. On the surface, it appeared that video did not enhance learning as was originally hypothesized. Rather than merely accepting these results at face value, the research questions sought to offer an explanation as to why the results turned out the way they did.

RQ_1.

Research question one asked, "What will be the perception of the students toward the use of the digital camera and laptop computer?" Before administering the survey, the initial thoughts about this question were positive in nature. With today's students having more technology available to them, it was thought that students would be more open and interested in using something different in class, especially if it were something to do with computers and cameras. The results (see Tables 4 & 5) showed that most of the students did like using the electronic equipment, but there were some who really didn't like it that much. While most of the students stated that they enjoyed using the equipment because it was fun/enjoyable and because they liked electronics, it was interesting to see the reasons why they did not like it. Students who did not like using the equipment felt that it took up too much time and took too long to use. For future studies, it may be wise to reduce, as mentioned earlier in this chapter, the frequency in which video is used. Doing so may help alleviate some of the boredom and repetitiveness. However, reducing the time the students are exposed to the video feedback is much harder to accomplish. With a 50 minute class, there may only be 25 or 30 minutes of actual activity time. The students in the current study only came over for approximately 5 minutes each time they used the video. On the one hand, reducing this time may be good, but on the other, their exposure to the video feedback and equipment would be so minimal that it may rush them in their analysis of their performance. Either way, it is difficult to determine what would be the best solution without further testing.

RQ_2.

Research question two asked, "After having the opportunity to see themselves on the digital video playback, will the students feel that it helped them understand the goal of the movement?" Gentile (1972) and Fitts and Posner (1967) state that one of the necessary stages that every learner must pass through in learning motor skills is understanding the movement itself and how their body can reproduce that movement in the most fluent and efficient manner possible. Since the participants in the current study were primarily in the beginning stages of soccer juggling, it was hoped that the majority of students would answer positively to this question. The majority did answer positively by saying that the video feedback did help them identify what they were doing wrong or needed to correct (see Tables 6 & 7). However, other students stated that it did not help them due to the fact that they could not see, notice, or feel their mistakes. Why couldn't these students see their mistakes? Was the video feedback too overwhelming for them? Did they need the skill broken down further into parts before using the video? Should the students have practiced more and gained a better grasp of the movement itself before trying to identify their mistakes? Were the students genuinely trying to identify their mistakes or were they merely doing just enough to get by? These questions all come to mind after looking at the statements given by the students. It was also interesting to note that some of the students stated they could not "feel" their mistakes. Maybe these students did need more practice with the skill before using the video feedback. This way, when they saw themselves, they could possibly piece the video together with their "feeling" or kinesthetic awareness and evaluate better what needed to be done.

For students who responded that the video feedback was not helpful because they could not see any improvement or that it did not belong in physical education, it brings a perplexing thought to mind. If these students feel this way toward using video in physical education, how is it that they cope with other classes and the introduction of new teaching methods? For the students who could not see improvement, do they give up and quit because they can't see improvement in their history class or English class? What if they had a low grade on a math test and received another one on a homework assignment? Do they give up because they do not see improvement? It would be interesting to find out their perceptions in other classes and compare them to their perceptions in physical education. Doing so might paint a clearer picture of whether it is the subject matter or the actual video itself that plays a more predominant role in their attitudes toward using it.

For those that felt video did not belong in physical education, it may be partly due to past teachers never exposing them to the use of video. Maybe if prior use in earlier grades established an idea about video, then students responding negatively may respond differently if it were used again.

RQ_3.

Research question three asked, "Will the use of the digital camera, laptop computer, and checklist help the students analyze their performance?" For this question, student responses were very similar to those of the second research question. They indicated that being able to see their own performance was one benefit of using the video equipment and the checklist. Schmidt (1988), Bandura (1997), and Magill (1998) all highlight the benefits of seeing model performances and the manner in which it can help build a schema for performing the movement correctly. However, using video feedback of students' performances and comparing them right beside a video of a model performance would seem to be more of a personalized comparison. It provides the individual with a chance to see both the model and their own performance at a slower frame rate and allows them the opportunity to compare the performances at their own pace. Along with the visual comparison, the checklist added some cues about the movement and some things to think about when performing the skill in the future. Overall, it seemed that the combination of the equipment and the checklist had a positive effect on the students' perceptions of learning the skill.

On the other hand, most students who felt it did not help them in analyzing their performance did not give a reason. Reasons such as not "feeling" mistakes and failure to see improvement have been discussed, but some students gave the reason that they already found out on their own what was wrong with their movement. It would be interesting to discover in future studies when the use of video feedback ceased to be helpful for these students and how and at what point they found out what they were doing incorrectly. Also, what these students considered incorrect may or may not have been the same factors that their physical education teacher would consider incorrect. Identifying such a point in time may uncover another characteristic about using video that links its use to enhancing learning.

RQ_4.

Research question four asked, "Will the use of video feedback increase students' motivation to learn?" With the exposure students have had to video in other classes and environments combined with the enhancements made in video technology, it was surprising to see the results for this question (see Tables 10 & 11). An overwhelming majority stated that using video feedback did not motivate them at all. In the literature, it has been shown that visual feedback plays an important role (Adams, Gopher, & Lintern, 1977; Bandura, 1977; Rikli & Smith, 1980; Schmidt & Wrisberg, 1973) in learning motor skills and it also serves as a motivational tool (Bandura, 1997; Magill, 1998; Schmidt, 1988, 1991). If a person can see their mistakes or see the movement correctly executed, it gives him/her a correct frame of reference to compare against when they try and perform the same movement. Apparently in this study, the motivational factor was not very noticeable. Aside from giving no reason at all, the statement that may explain why motivation levels were so low deals with the skill or sport being used. Students obviously did not like soccer as the sport to be used. However, this attitude may be present the whole school year regardless of the sport being taught or used. There will always be those students that do not like particular sports, especially if it is a sport that he/she is not skilled in. Still, with this being the case, the question of how to get students motivated to learn new skills or improve the ones they are weak in still remains a mystery.

Other students mentioned that it took too much time. Once again, the issue of time is a factor that should be addressed in future studies. Students in the current study started getting frustrated and upset when they were called over to juggle the ball and view their videos. After the third week into the study, pulling students away from class tournaments or from other games/activities was a definite factor that decreased their motivation. Begrudgingly, many students would juggle the ball and record their videos. Pretty soon, they grew tired of coming over and then at one point, started asking how many days were left that they had to come over and do that. It seems logical to conclude that many of the students who didn't give a reason about the lack of motivation of video feedback would fall into this category. The novelty of using the video had worn off. As discussed earlier, the motivational levels may have been different if video had been used in their physical education classes prior to this study. Rather than simply seeing the video feedback as something that peaked their interest for a short time, if it were gradually implemented into their physical education classes as a standard part of daily or weekly activities, then it may have been viewed in a different light.

Closing

Since its inception, video has been utilized in so many different environments and in so many different ways. From recording family vacations to documenting history, video has provided another means through which people can share information as well as express themselves and their views. In education, video has shown great potential as a tool for enlightening students and motivating them to learn. While video usage has been well documented in other subject areas, physical education has only explored its use in a limited capacity. Unlike coaching and athletics, which have utilized video in a myriad of ways, physical education has not yet found a consistent framework to warrant the continual use of video feedback in the curriculum. Whether this lack of use stems from fear of change or from hesitancy about its usefulness, it is with hope that future research can provide a framework that highlights the use of video and how it can be successfully integrated into physical education classes. Providing such a knowledge base would enable physical educators to make an informed decision about implementing video within their classes and would help alleviate the guesswork as to its effectiveness.

Conclusions

Based upon the findings within the limits of this investigation, the following conclusions have been made:

1. The use of digital video feedback in the context of this study produces similar improvements in motor skill performance when compared with other methods of feedback delivery.
2. Both males and females receive similar improvements in performance when using digital video feedback.
3. Using digital video feedback appears to help some students understand better the goal of the movement and aid them in the analysis of their performance.
4. The frequency of using digital video feedback has an impact on students' attitudes and motivation levels.

Recommendations for Future Research

1. So that students take a more involved approach to using video feedback, the physical education teacher may need to be involved. In future studies, the teacher could review digitally recorded performances with the students in either

small groups or in one-on-one sessions. During these sessions, the teacher could help students see what they are doing right, help them pinpoint their mistakes, and make recommendations on what to work on. These sessions could also serve as a way for the teacher to help students actually know what to look for when executing motor skills. These sessions could be as little as once every two to four weeks or as much as once a week with students. The frequency would depend upon the availability of the teacher, the length of the class, and the number of students involved.

2. Using a variety of motor skills ranging from low to high difficulty may provide some insight into the effectiveness video feedback may have with specific motor skills. By investigating various levels of difficulty, it could be possible to start identifying where video feedback may provide the most benefit. Also, if students' skill levels were known prior to implementing the intervention, it would not only identify the difficulty of motor skill video feedback is best used with, but also it could lay the groundwork for identifying how skilled the students need to be in order to benefit from using video feedback.
3. Using video feedback with a tactical games approach in a particular unit may increase the awareness of the students about the skill and why it is performed. Putting the skill into its true context may help improve the students' interest in the skill and improve game-play later in the unit. Furthermore, during a specified sport unit, rather than viewing video sessions individually, they could be viewed and discussed with students at a station. The teacher could offer comments to the group and correct student mistakes right there at the station. This method may not be as individualized, but it would still let students know that the teacher is interested in their progress and would open up avenues for showing how to better use the practiced skill in a more realistic game situation.
4. To gain more information about the effects of video feedback on gender, it would be interesting to place students in different interventions and allow the males and females in those interventions to be exposed to the video feedback for various time intervals. This may give an indication if males or females perform better if they are exposed to video feedback for specific amounts of time.

5. Further qualitative research could be done to explore the thoughts, feelings, and attitudes of participants during their session while using video feedback. Finding out this information would give educators a better feel for their students' attitudes and motivation toward using video and it would also provide valuable information as to when students start becoming bored or tired of that particular method of teaching.
6. To alleviate overuse and decrease boredom levels, the frequency with which video feedback is used each week will need to be reduced. The video should still be used 5 weeks or longer, but instead of having students review their videos daily, it may be better to use video feedback once a week or once every two to three weeks. Another option may be to allow those students that are more skilled or highly motivated to use the video equipment on an individual basis.
7. Another possibility to reduce overuse and boredom in future studies is to create a more implicit learning environment. Allow the students a choice of when they will use their video feedback rather than forcing them to view their performance every time. By doing this, it may reveal that students prefer this more self-regulated style of learning and as a result, gain more benefit from using digital video feedback.

APPENDIX A
TIME FRAME OF STUDY

Time Frame of Study

Days 1-2

Intervention Assignment Test & Assign Students to an Intervention

Days 3-5

Train Students on Equipment & Scoring Performances

Days 6-25

Verbal Intervention (VB):
-Performs skill
-Analyzes skill performances using written checklist

Traditional Intervention (T)
-Views performance model & performs skill
-Analyzes skill performances using written checklist

Video Intervention (V):
-Views performance model & performs skill
-Digitally records skill performances
-Analyzes skill performances with performance model, checklist, & digitally recorded performances

Days 26-27

Post-Performance Test & Surveys

Days 28-29 (2 weeks after Post-Performance Test)

Retention Test

APPENDIX B
INTERVENTION ASSIGNMENT TEST

Subject No. ______ **Intervention Assignment Test**

Last Name: ____________________ **First Name**: _______________________

Gender: M F **Teacher**: _________________________

Grade level: 8th **Age**: 10 11 12 13 14

Trial #1: _____
Trial #2: _____
Trial #3: _____
Trial #4: _____

TOTAL: _____ / 4 = $\boxed{\quad}$ Intervention Assignt. Score (IAS)

Subject No. ______ **Intervention Assignment Test**

Last Name: ____________________ **First Name**: _______________________

Gender: M F **Teacher**: _________________________

Grade level: 8th **Age**: 10 11 12 13 14

Trial #1: _____
Trial #2: _____
Trial #3: _____
Trial #4: _____

TOTAL: _____ / 4 = $\boxed{\quad}$ Intervention Assignt. Score (IAS)

Subject No. ______ **Intervention Assignment Test**

Last Name: ____________________ **First Name**: _______________________

Gender: M F **Teacher**: _________________________

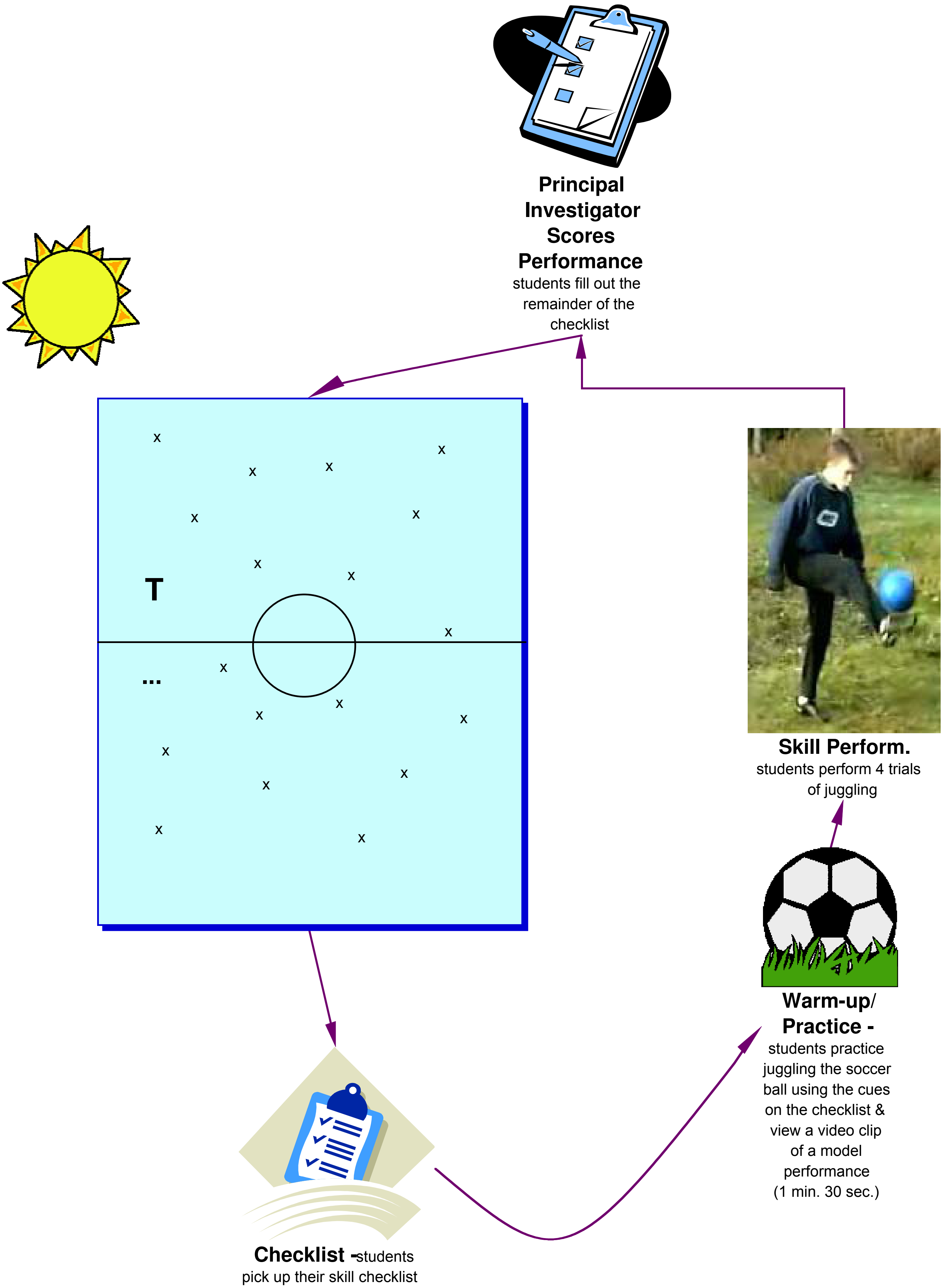
Grade level: 8th **Age**: 10 11 12 13 14

Trial #1: _____
Trial #2: _____
Trial #3: _____
Trial #4: _____

TOTAL: _____ / 4 = $\boxed{\quad}$ Intervention Assignt. Score (IAS)

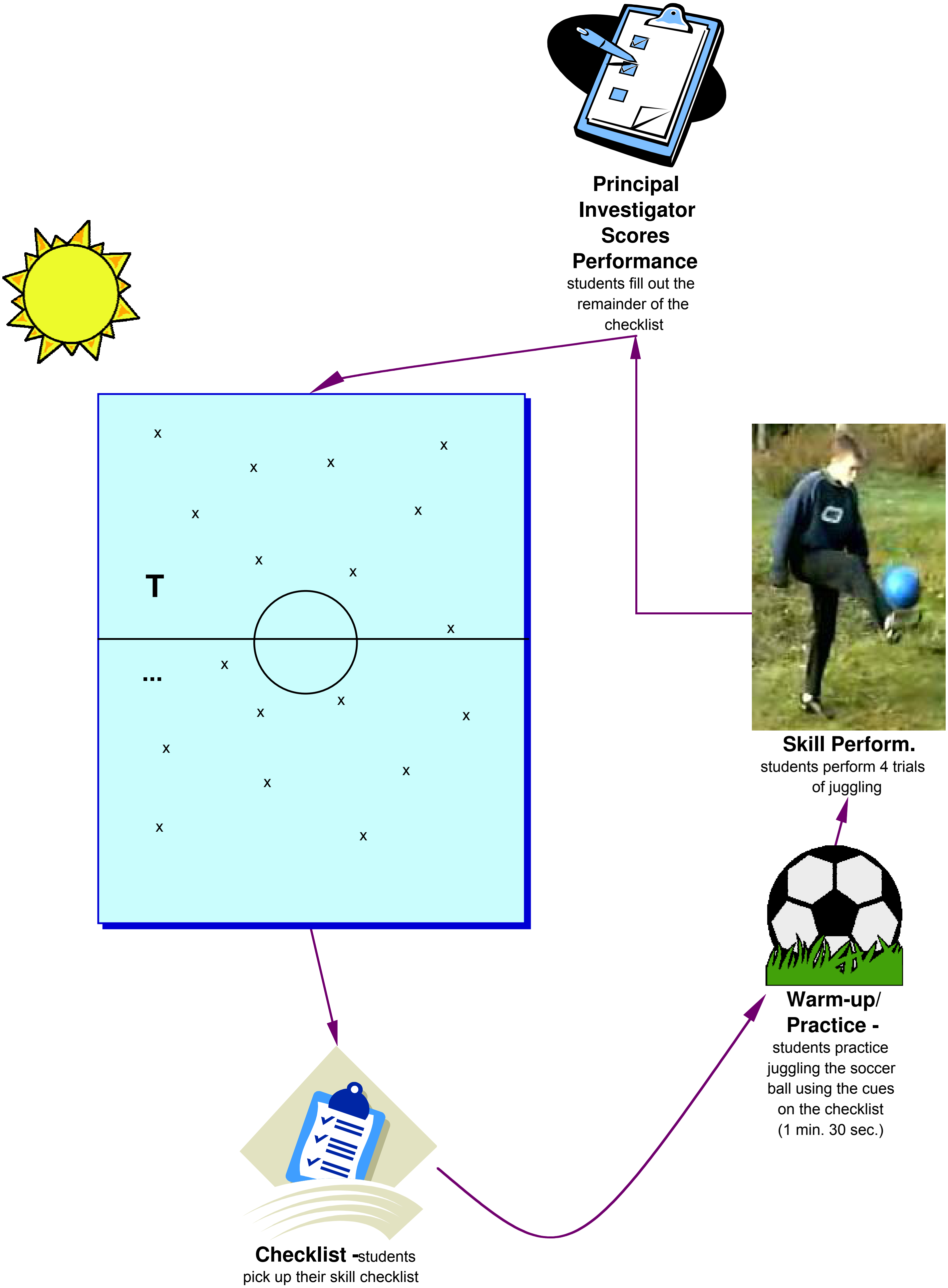
APPENDIX C

IN-CLASS ROTATION FOR THE TRADITIONAL INTERVENTION

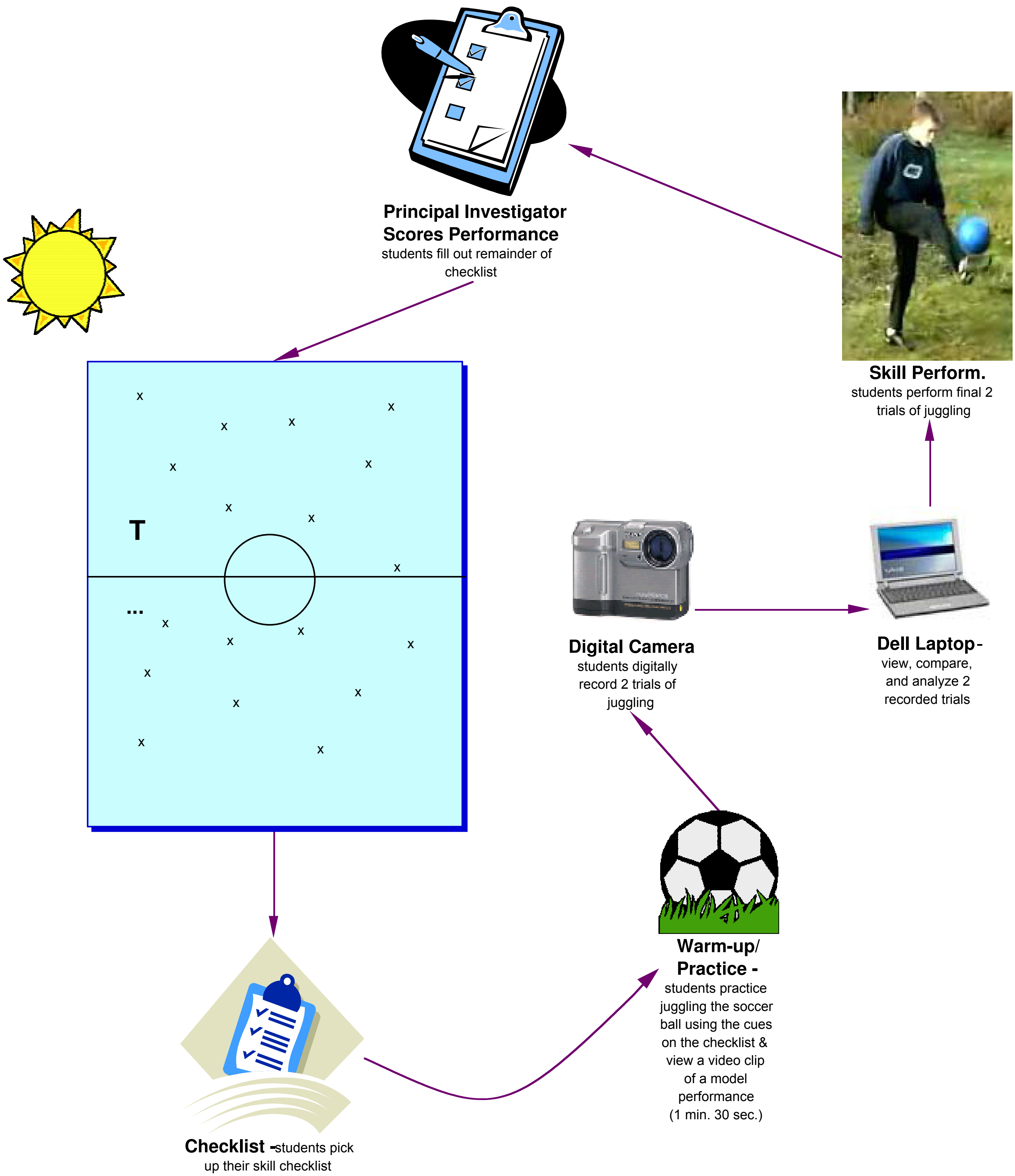

Principal Investigator Scores Performance
students fill out the remainder of the checklist
T
...
Skill Perform.
students perform 4 trials of juggling
Warm-up/ Practice -
students practice juggling the soccer ball using the cues on the checklist & view a video clip of a model performance (1 min. 30 sec.)
Checklist -students pick up their skill checklist

APPENDIX D

IN-CLASS ROTATION FOR THE VERBAL INTERVENTION


Principal Investigator Scores Performance
students fill out the remainder of the checklist
T
...
Skill Perform.
students perform 4 trials of juggling
Warm-up/ Practice -
students practice juggling the soccer ball using the cues on the checklist (1 min. 30 sec.)
Checklist -students pick up their skill checklist

APPENDIX E
IN-CLASS ROTATION FOR THE VIDEO INTERVENTION


Principal Investigator Scores Performance
students fill out remainder of checklist
Skill Perform.
students perform final 2 trials of juggling
T
Digital Camera
students digitally record 2 trials of juggling
Dell Laptop -
view, compare, and analyze 2 recorded trials
Warm-up/ Practice -
students practice juggling the soccer ball using the cues on the checklist & view a video clip of a model performance
(1 min. 30 sec.)
Checklist - students pick up their skill checklist

APPENDIX F

SKILLS CHECKLIST FOR THE TRADITIONAL INTERVENTION

❑ **T** **Subject No: _______**

First Name: ____________________ Last Name: ____________________ M or F

1

Record in the blanks below how many times you juggled the soccer ball with your feet.
(*Remember to only count the number of foot contacts***)**

1st Attempt: ________

2nd Attempt: ________

3rd Attempt: ________

4th Attempt: ________

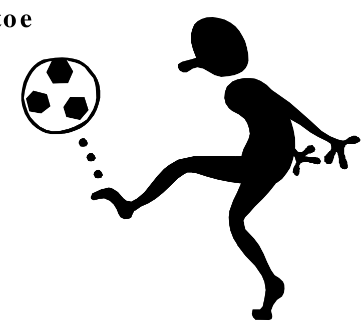
2

RATE yourself on how well you did today for each of the cues listed.

	Not at all	*Very few times*	*Half of the time*	*Most of the time*	*All of the time*	
a) My knees were bent	**1**	**2**	**3**	**4**	**5**	
b) I kept my eyes on the ball	**1**	**2**	**3**	**4**	**5**	
c) My arms were out for balance	**1**	**2**	**3**	**4**	**5**	
d) I made controlled, soft touches	**1**	**2**	**3**	**4**	**5**	
e) I kept the ball close to my body	**1**	**2**	**3**	**4**	**5**	

3

What are some things **that you could work on to improve** your juggling?
Some Examples: -bend my knees more
-get my hands out of my pockets
-kick the ball with my shoelaces rather than my toe



APPENDIX G

SKILLS CHECKLIST FOR THE VERBAL INTERVENTION

❑ **VB** **Subject No:** _______

First Name: ____________________ Last Name: ____________________ M or F

1

Record in the blanks below how many times you juggled the soccer ball with your feet.
(*Remember to only count the number of foot contacts***)**

1st Attempt: ________

2nd Attempt: ________

3rd Attempt: ________

4th Attempt: ________

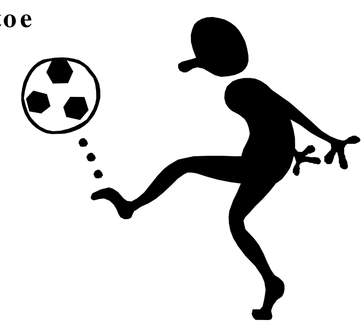
2

RATE yourself on how well you did today for each of the cues listed.

	Not at all	*Very few times*	*Half of the time*	*Most of the time*	*All of the time*	
a) My knees were bent	**1**	**2**	**3**	**4**	**5**	
b) I kept my eyes on the ball	**1**	**2**	**3**	**4**	**5**	
c) My arms were out for balance	**1**	**2**	**3**	**4**	**5**	
d) I made controlled, soft touches	**1**	**2**	**3**	**4**	**5**	
e) I kept the ball close to my body	**1**	**2**	**3**	**4**	**5**	

3

What are some things **that you could work on to improve** your juggling?
Some Examples: -bend my knees more
-get my hands out of my pockets
-kick the ball with my shoelaces rather than my toe



APPENDIX H

SKILLS CHECKLIST FOR THE VIDEO INTERVENTION

❑ V **Subject No:** _______

First Name: ____________________ **Last Name:** ____________________ M or F

1 Have your partner video your first two attempts at juggling and record the numbers in the blanks below. **(***Remember to only count the number of foot contacts***)**

1st Attempt (video): _________ **2nd Attempt (video):** _________

2 Record the file numbers of your videos: **File #1**:__________ **File #2**:__________

3 **OPEN** up your videos on the computer, **VIEW** them, & then **COMPARE** them to the model. Answer the following questions:

a)How did you do on the cues listed in Step #5?

b)List some of your mistakes.

4 Now that you have seen your videos, try juggling the ball **two more times** correcting any mistakes that you saw in your videos. Then, record your numbers in the blanks below.

3rd Attempt: _________ **4th Attempt:** _________

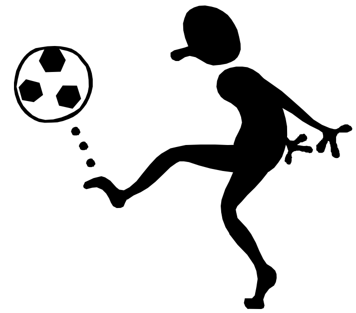
5 **RATE** yourself on how well you did today for each of the cues listed.

	Not at all	*Very few times*	*Half of the time*	*Most of the time*	*All of the time*	
a) My knees were bent	**1**	**2**	**3**	**4**	**5**	
b) I kept my eyes on the ball	**1**	**2**	**3**	**4**	**5**	
c) My arms were out for balance	**1**	**2**	**3**	**4**	**5**	
d) I made controlled, soft touches	**1**	**2**	**3**	**4**	**5**	
e) I kept the ball close to my body	**1**	**2**	**3**	**4**	**5**	

6

On the back of this page, list some things **that you could do to improve** your juggling?

Some examples: -bend my knees more
-get my hands out of my pockets
-kick the ball with my shoelaces rather than my toe



APPENDIX I
POST-PERFORMANCE TEST

Subject No. _______ **Post-Performance Test** Intervention: T VB V

Last Name: ______________________ **First Name**: _________________________

Gender: M F **Teacher**: ___________________________

Grade level: 8th **Age**: 10 11 12 13 14

Trial #1: ______
Trial #2: ______
Trial #3: ______
Trial #4: ______

TOTAL: _____ / 4 = ☐ Post-Performance Score (PPS)

Subject No. _______ **Post-Performance Test** Intervention: T VB V

Last Name: ______________________ **First Name**: _________________________

Gender: M F **Teacher**: ___________________________

Grade level: 8th **Age**: 10 11 12 13 14

Trial #1: ______
Trial #2: ______
Trial #3: ______
Trial #4: ______

TOTAL: _____ / 4 = ☐ Post-Performance Score (PPS)

Subject No. _______ **Post-Performance Test** Intervention: T VB V

Last Name: ______________________ **First Name**: _________________________

Gender: M F **Teacher**: ___________________________

Grade level: 8th **Age**: 10 11 12 13 14

Trial #1: ______
Trial #2: ______
Trial #3: ______
Trial #4: ______

TOTAL: _____ / 4 = ☐ Post-Performance Score (PPS)

APPENDIX J

STUDENT SURVEY – TRADITIONAL INTERVENTION

Student Survey (T)

First Name: ______________________ Last Name:______________________

Age: _______

Gender: ☐ Male ☐ Female Grade level: ☐ 6th ☐ 7th ☐ 8th

School: Florida State University School County: LEON

Date: _________ Time/Class Period: ___________

Please answer the following questions listed below. If you have any problems or don't understand a question, just raise your hand or go over to Mr. Taylor for help. If you need extra space to write your answer, you may use the back of the page.

1. Do you play on any sports teams for your school? ☐ YES ☐ NO
   If you do play sports for your school, list the sports that you play:

________________ ________________ ________________

2. Do you play on any sport(s) teams outside of school? ☐ YES ☐ NO
   If you do play on any sports teams outside of your school, list the sports that you play:

________________ ________________ ________________

3. Does your coach use videos or a camcorder during your practices or games?
   ☐ YES ☐ NO

4. Does your coach go over or review videos with you at practice or before games?
   ☐ YES ☐ NO

5. Have you ever used a skills checklist in your physical education class?
   ☐ YES ☐ NO
   If you have, when and how did you use it?

6. Did you like using the skills checklist during your physical education class?
   ☐ YES ☐ NO

7. What did you like about using the skills checklist?

8. What did you not like about using the skills checklist?

9. Did seeing the performance model on the laptop and using the skills checklist help you understand better what you were doing when you were trying to improve your juggling?
☐ YES ☐ NO

If you answered YES, why do you feel that these things helped you?
If you answered NO, why do you feel that using these things did not help you?

10. Did seeing the performance model and using the checklist help you understand what you were doing right or wrong when you were juggling? ☐ YES ☐ NO

If you answered YES, why do you feel that using these things helped you?
If you answered NO, why do you feel that using these things did not help you?

11. Would you like to use more skills checklists in your physical education class?
☐ YES ☐ NO

Why or why not?

12. Did using the skills checklist make you more interested in learning the skill?
☐ YES ☐ NO

Why or why not?

APPENDIX K

STUDENT SURVEY – VIDEO INTERVENTION

Student Survey (V)

First Name: ______________________ Last Name:______________________

Age: _______

Gender: ☐ Male ☐ Female Grade level: ☐ 6th ☐ 7th ☐ 8th

School: Florida State University School County: LEON

Date: _________ Time/Class Period: ___________

Please answer the following questions listed below. If you have any problems or don't understand a question, just raise your hand or go over to Mr. Taylor for help. If you need extra space to write your answer, you may use the back of the page.

1. Do you play on any sports teams for your school? ☐ YES ☐ NO
   If you do play sports for your school, list the sports that you play:

_________________ _________________ _________________

2. Do you play on any sport(s) teams outside of school? ☐ YES ☐ NO
   If you do play on any sports teams outside of your school, list the sports that you play:

_________________ _________________ _________________

3. Does your coach use videos or a camcorder during your practices or games?
   ☐ YES ☐ NO

4. Does your coach go over or review videos with you at practice or before games?
   ☐ YES ☐ NO

5. Have you ever used a digital video camera before using the one in your class?
   ☐ YES ☐ NO
   If you have, where and how did you use it?

6. Did you like using the digital video camera and computer during your physical education class? ☐ YES ☐ NO

7. What did you like about using the video equipment?

8. What did you not like about using the video equipment?

9. Did seeing yourself on the computer and viewing your video help you understand better what you were doing when you were trying to improve your juggling? ☐ YES ☐ NO

If you answered YES, why do you feel that using the video and computer helped you?
If you answered NO, why do you feel that using the video and computer did not help you?

10. Did using the digital camera, laptop, and checklist help you understand what you were doing right or wrong when you were juggling? ☐ YES ☐ NO

If you answered YES, why do you feel that using these things helped you?
If you answered NO, why do you feel that using these things did not help you?

11. Would you like to use the digital video equipment in your physical education class?
☐ YES ☐ NO

Why or why not?

12. Did using the digital camera and laptop make you more interested in learning the skill?
☐ YES ☐ NO

Why or why not?

APPENDIX L
TEACHER SURVEY

Teacher Survey

First name: ________________________ Last Name: __________________________

Age: _______

Gender: □ Male □ Female

Grade level taught: 8th grade

School: Florida State University School

Number of years teaching physical education: ________

Subjects taught other than P.E.: N/A 1)_______________ 2)________________

Date: _______________ Time/Class period: __________________

Please answer the following questions listed below.

1. Do you coach any sports at the school? □ YES □ NO
   If you do, list the sport(s) you coach:

___________________ ____________________ ____________________

2. Do you coach any sports outside of the school? □ YES □ NO
   If you do, list the sport(s) you coach:

___________________ ____________________ ____________________

3. Do you use any video or other technology with your team(s)? □ YES □ NO
   (**Can be your school team, outside team, or both)**

   If you do, please check all that apply.

□ Loop films	□ Overhead projector
□ Analog video/Video camera/TV	□ Digital video/Digital video camera
□ 35mm camera/Still pictures	□ Digital camera/Still pictures
□ Opaque projector	□ Videodiscs
□ Laptop or desktop computer	□ Other ______________________

4. How do you feel about the use of technology in your physical education classes?

5. In your opinion, do you think using technology in your physical education classes is or would be an effective means of helping students learn? Why or why not?

6. Have you had any experience with using digital video? If so, what type of experience(s) have you had?

7. Do you currently use any type of technology in your physical education classes? If so, please list what you use.

APPENDIX M
HUMAN SUBJECTS DOCUMENTATION

Florida State
UNIVERSITY

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2763
(850) 644-8633 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 3/2/2005

To:
Seann Taylor
1502 Pullen Rd Apt C
Tallahassee FL 32303

Dept.: **SPORT MANAGEMENT/PHYSICAL ED.**

From: **Thomas L. Jacobson, Chair**

Re: **Use of Human Subjects in Research**
A study of the effectiveness of modern digital imaging techniques with middle school physical education students during the development and acquisition of motor skills

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on **2/9/2005**. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals which may be required.

If the project has not been completed by **2/8/2006** you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

cc: Charles Imworld
HSC No. 2005.073

FLORIDA STATE UNIVERSITY SCHOOLS
3000 School House Road
Tallahassee, Florida 32311

Jesse Jackson, Director

Neal Trafford	**Dr. Rodney Ryan**	**Susan Martelli**
Elementary School Principal	Middle School Principal	High School Principal

March 29, 2006

Dear Mr. Taylor:

It is my pleasure to assure you that your research project "A study of the effectiveness of modern digital imaging techniques with middle school physical education students during the development and acquisition of motor skills" was approved on August 29, 2005 for the Florida State University Schools. Your study investigated the effectiveness of digital video in providing feedback for learning a new motor skill to 8th graders. The study took place in the Fall of 2005 during physical education classes under the guidelines of the FSU IRB human subjects protocol.

We value the opportunity to have been of assistance to you and look forward to hearing about your findings in the future.

Sincerely,

Marten Scheffers

Marten Scheffers, Ph.D.
Research Director FSUS

Phone: (850) 245-3729
Fax: (850) 245-3721

Phone: (850) 245-3700 Fax: (850) 245-3911 Mail Code: 7792
"An equal opportunity employer"

Parent Consent Form

Dear Parent(s)/Guardian(s),

Within the next few weeks, your child will have the opportunity to participate in a research study conducted by Seann Taylor, a doctoral student in the physical education department at Florida State University. This study is entitled "A Study of the Effectiveness of Modern Digital Imaging Techniques With Middle School Physical Education Students During the Development and Acquisition of Motor Skills." The purpose of this study is to explore the use of current video technology and how it may enhance the performance of a skill when combined with regular feedback. Since the study will be conducted during your child's normally scheduled physical education class, there will be no additional strenuous exercise. The only exercise your child will perform for this study will be the motor skill of soccer juggling. There will be no additional risk placed upon your child. Their physical education teacher will be present at all times.

Throughout the course of the study, your child may be videotaped while he/she juggles the soccer ball. Using this video, your child may have the opportunity to analyze his/her own performance. In doing so, your child will receive feedback from the model video performance, a written checklist, and from their own skill performance. The identity of your child and any data collected will remain confidential at all times. Any memory sticks, checklists, or other material used in the study will be stored in a locked filing cabinet when they are not being used. All videos of your child practicing a skill will be kept until February 2006. At this time, the memory sticks will be erased.

At any time during the study, your child may be withdrawn without prejudice or penalty. If you wish for your child not to participate or if they are withdrawn from the study, it will in no way affect their participation grade or their grade for the class. If you have any questions, comments, or concerns about this study and your child's involvement, you may contact Seann Taylor at 850-422-2348 or through e-mail at t.seann@gmail.com. You may also contact Dr. Charles Imwold at 850-644-0918. If you have any further questions or concerns about the rights of your child as a participant in this research study, you can contact the Chair of the FSU Human Subjects Committee, Institutional Review Board through the office of the Vice President for Research at 850-644-8633. If you would like for your child to participate in this study, please read, sign, and send the bottom portion of this form back with your child to his/her physical education teacher. Thank you for your time and consideration.

I have read and understand the above letter describing the study entitled "A Study of the Effectiveness of Modern Digital Imaging Techniques With Middle School Physical Education Students During the Development and Acquisition of Motor Skills." I understand both the involvement of my child within this study and that my child may be videotaped throughout the course of this study. I do hereby give permission for my child to participate in this study.

___________________________	___________________________
Child's name (Printed)	Parent'(s) Name (Printed)
___________________________	___________________________
Date	Parent'(s) Signature

Youth Assent Form

During your physical education class, Seann Taylor, a doctoral student in the physical education department at Florida State University, will be coming to do some research and collect some information. Seann will be studying how the use of video may help in learning different motor skills.

Your physical education teacher will still be teaching your class at all times. However, during class you may be instructed, depending upon the group you are assigned to, to come over to a station where a Sony Mavica digital camera and computer laptop will be set up. At this station, you will practice and perform the motor skill of soccer juggling. After a couple of minutes of practice, your partner will record you performing the skill. After you and your partner have recorded each other juggling the soccer ball, you will take the memory stick out of the digital camera and take it over to the laptop computer. At the computer, you will then be able to see yourself practicing the skill and be able to compare your practice to a model performance and with a cues checklist to see what you may be doing wrong.

All memory sticks that have videos of you performing the skill will be taken up daily and placed in a locked filing cabinet. Only Seann will see the videos on these memory sticks and he will be the only one that knows who you are and the school you go to. At the end of the study, in February 2006, all the memory sticks that have your skill performances on them will be erased.

For this study, there will be no additional physical exercise you must do (except for juggling the soccer ball) or additional risk involved. Your teacher will be present at all times. Although your parents may have given you permission to participate in this study, you do not have to participate if you do not want to. Also, you may withdraw from the study at any time. If you choose to withdraw from the study, it will not affect your grade in any way nor will you be penalized for not participating.

If you would like to participate in this study, please read and sign the bottom portion of this sheet and return it either to your physical education teacher or to Seann.

I have read and understand the above letter describing the study. I understand that I may be videotaped throughout the course of this study. I do hereby voluntarily consent to participate in this study.

___________________________	___________________________
Youth Name (Printed)	Youth Signature

____
Date

Teacher Consent Form

Dear Physical Education Teacher,

Within the next few weeks, you and your physical education classes will have the opportunity to participate in a research study conducted by Seann Taylor, a doctoral student in the physical education department at Florida State University. This study is entitled "A Study of the Effectiveness of Modern Digital Imaging Techniques With Middle School Physical Education Students During the Development and Acquisition of Motor Skills." The purpose of this study is to explore the use of current video technology and how it may enhance the performance of a skill when combined with feedback. For this study, you will not have to teach any extra material or change what you are currently teaching. Students will meet at their regularly scheduled times and with their regularly scheduled class.

Based upon a group assignment test score, students will be randomly assigned to one of three groups: the traditional group (T), the video group (V), or the verbal group (VB). Throughout the study, students will be dismissed in groups of 4 to 8 students at a time to go over to a station and practice/perform the motor skill of soccer juggling. Those in the V group will digitally record two trials of their partner's skill performance and then take the memory stick from the digital camera to a laptop computer. At the laptop, the students will have a cues checklist and a model video to use to compare and correct their performance of the skill. They will then perform two more trials of the motor skill, fill out the checklist, and then return with the rest of the class. This will allow the V students a chance to critically think and analyze their own performance using both visual and written feedback. Those in the T group will be able to view a model performance on the laptop, but will only have the cues checklist and this model to analyze their skill performance. The VB group will only have the written checklist to use in analyzing their skill performance.

Although digital videotaping will be going on throughout the study, the identity of you and your students will be kept confidential at all times. The memory sticks, cues checklists, and any other material related to this study will be kept in a locked filing cabinet when not being used. All of the videos of the students performing the motor skill will be kept until February 2006. At this time, the memory sticks will be erased.

At any time during the study, you may withdraw without prejudice or penalty. If you have any questions, comments, or concerns about this study and your involvement, you may contact Seann Taylor at 850-422-2348 or through e-mail at t.seann@gmail.com. You may also contact Dr. Charles Imwold at 850-644-0918. If you have any further questions or concerns about your rights as a participant in this study, you may contact the Director of Research at your school or the Chair of the FSU Human Subjects Committee, Institutional Review Board through the office of the Vice President for Research at 850-644-8633. If you would like to participate in this study, please read, sign, and return the bottom portion of this form to Seann Taylor. Thank you for your time and consideration.

I have read and understand the above letter describing the study entitled "A Study of the Effectiveness of Modern Digital Imaging Techniques With Middle School Physical Education Students During the Development and Acquisition of Motor Skills." I understand my involvement and my classes' involvement within this study and realize that my students and me may be videotaped throughout the course of this study. I do hereby voluntarily consent to participate in this study.

___________________________ ___________________________
Teacher's Name (Printed) Date

____
Teacher's Signature

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