Effects of Two Instructional Models—Skill Teaching and Mastery Learning—on Skill Development, Knowledge, Self-Efficacy, and Game Play in Volleyball

Joyce M. Harrison, Lisa A. Preece, Connie L. Blakemore, Robert P. Richards, Carol Wilkinson, and Gilbert W. Fellingham
Brigham Young University

This study examined volleyball achievement and task-specific self-efficacy for 182 students in 6 beginning college volleyball classes taught using either the Mastery Learning or Skill Teaching models. Three instructors each taught one Mastery Learning and one Skill Teaching class. Assessments included the AAHPERD pass, set, and serve tests, the Stanley spike test, successful and unsuccessful game trials, Bandura-type self-efficacy scales, and a knowledge test. A random coefficients growth curve model analyzed the intercepts and slopes of the learning curves and revealed significant pre- to posttest improvement on skills tests, self-efficacy, and the percentage of correct passes and serves in game play for all students. No significant difference existed between the two models on average number of trials per day; rate of improvement for the pass, serve, or spike skills tests; self-efficacy; percentage of correct passes, sets, or serves in game play; contacts per serve in game play; or knowledge scores. The Mastery students’ rate of learning was significantly better on the set skills test (1.3 points higher) and the percentage of successful spikes in game play, in which they started significantly lower. The low-skilled students improved at a faster rate on the serve and on self-efficacy for the pass, set, and serve. Males had higher self-efficacy than females, while females increased more rapidly in self-efficacy for the pass, set, and serve. All results were analyzed at the .05 level of significance. Students learned to play volleyball and improved significantly in skill performances with either model.

Teaching is a complex and intricate experience involving the teacher, the student, and the environment. Earls (1983) stated that “few teachers . . . really make a difference in skill development for many of their students.” Further, “there is little evidence that conventional instruction is positively related to the learning and development of motor skills for most students” (p. 260). Graham (1987) agreed that we don’t appear to be succeeding in producing motor skill acquisition. However,

J.M. Harrison, L.A. Preece, C.L. Blakemore, R.P. Richards, and C. Wilkinson are with the Department of Physical Education at Brigham Young University, Provo, UT 84602. G.W. Fellingham is with the Department of Statistics at Brigham Young University.
Cruickshank (1986) noted that some teachers make more of a difference than others. While the reasons for this are varied, it is the goal of sport educators to have students play the game well enough to enjoy participation.

It makes sense to explore the methodologies of those teachers who do make a difference. Teachers must structure the class environment so students respond to motor learning instruction with greater appropriate practice (Silverman, Subramaniam, & Woods, 1998). Silverman (1993) reported a significant relationship between appropriate practice trials and achievement. Appropriate practice of motor skills (quality rather than quantity) is heavily substantiated by researchers (Ashy, Lee, & Landin, 1988; Buck, Harrison, & Bryce, 1991; Rink, 1996; Silverman, 1991, 1993; Silverman, Subramaniam et al., 1998; Silverman, Tyson, & Krampitz, 1993). If teachers accept responsibility for student outcomes, as suggested by Porter and Brophy (1988), every avenue of curriculum development should be explored. The teacher must consider student perceptions and also the learning environment because both affect final achievement outcomes (Lee, 1997). Sweeting and Rink (1999) suggest that an appropriate environmental design helps students elicit an initial movement pattern and is also a factor in achievement outcomes.

In a typical physical education curriculum, about two thirds of the time is spent in game teaching and learning (Griffin, Mitchell, & Oslin, 1997). Traditionally sport skills are taught with tasks presented and practiced in isolation and later incorporated in game situations. Rink (1993) suggests that skills should be developed progressively, refined, and finally applied in actual game situations. This is best achieved through four game play stages. These stages agree with Barrett’s (1977) three-phase process of game playing and Graham, Holt/Hale, and Parker’s (1987) levels of precontrol, control, utilization, and proficiency.

Rink (1996) emphasized the importance of being able to describe good teaching and summarized the research on effective teaching in physical education as follows. First, students need sufficient time to learn skills well enough to use them in game situations. Practicing challenging yet not overly difficult tasks in gamelike conditions leads to higher student success rates. Students must be cognitively involved in their own learning. Effective managers focus students on learning rather than compliance. Effective teachers use appropriate content development and communicate effectively to learners using demonstrations, verbal cues, and specific feedback. Direct instruction of motor skills has been substantiated as an effective way to teach physical education (French et al., 1991; Silverman, 1991; Sweeting & Rink, 1999; Werner & Rink, 1989). Direct instruction usually means teaching with small steps in a task-oriented environment, with explicit instructions on what students are to do, high student engagement with content, and immediate feedback to students (Rink, 1996).

Research examining skill teaching with methods incorporating the principles espoused by Rink (1996) must focus on how physical educators mentor students to play more successfully in competitive game situations. Buck and Harrison (1990) determined that when game play was used to teach skill to beginning volleyball players, the level of play decreased, and low-ability students had very few contacts with the ball and were not as successful when contact was made. During skill instruction and the practices immediately following, the percentage of successful trials increased, but dropped considerably during game play. This indicated a need for more skill instruction throughout the unit, so students gain confidence and proficiency in skill execution during game situations. These results agreed with
those of Parkin (1981) and Parker (1984). Students should not be expected to play in the real game until they are confident at skill execution. Earls (1983) suggested that a common mistake made by physical educators is to move from practice drills directly to competitive games before students have the skills necessary to be successful.

While examining how skills are taught, those to whom skills are taught must not be neglected. Students are unique individuals, with different aptitudes, needs, and aspirations, who learn in various ways. Carroll (1963) developed a model of learning indicating that degree of learning equals a ratio of time spent to time required. Time required included the factors of aptitude, ability to understand, and quality of instruction. Time spent referred to opportunity and perseverance. Effective teachers recognize the diversity among individuals and strive to meet their individual needs. However, Ennis (1989) suggests that “while we have paid lip service to differences among students, we continue to plan curriculum and instruction as though our learners represent one homogeneous group” (p. 1). For appropriate practice to occur, teachers must factor in student skill level, both individually and collectively. As Carroll (1963) points out in his degree of learning model, perseverance, aptitude, and ability to understand are critical factors in success. Silverman (1993) and Solmon and Lee (1996) indicate initial skill level plays a major role in student learning and achievement. Low-skilled students tend to improve more with similar amounts of appropriate practice, but they often make more mistakes while learning and have fewer appropriate trials. At the same time, they have the capacity for larger absolute gains (Silverman, 1993). Teachers need to deal with the diversity in student skill levels within a class, and a variety of teaching strategies may need to be incorporated. Pettigrew and Heikkinen (1985) report that student achievement is higher when a variety of teaching styles is used. Two direct teaching strategies advocated by various researchers are Skill Teaching and Mastery Learning. Some controversy exists as to which model is more effective in teaching sport skills, especially for low-skilled learners. Each model has been described in the literature as the only “true” teaching method; however, no research has compared them directly.

The Skill Teaching model, developed by Harrison and Buck (Harrison, Buck, & Pellett, 1995), uses Rink’s (1993) content analysis system and Mosston and Ashworth’s (1994) inclusion style. French et al. (1991) determined that students taught with teaching progressions, such as those in Rink’s system, had higher skill posttest scores than those taught by practicing the tests. However, low-skilled students did not improve because the tasks were considered to be inappropriate for their abilities. Harrison, Buck et al. (1995) also found increased game play performance using the Skill Teaching model, which involves a sequence of game-like drills and modified games to teach game play.

Mastery Learning proponents contend that low-skilled students learn more with Mastery techniques than in regular classes (Blakemore, 1985, 1986; Blakemore, Hilton, Harrison, Pellett, & Gresch, 1992). Benjamin Bloom (1976, 1987), the first to describe a working model for Mastery Learning, asserted that Mastery Learning brings all learners to a high level of achievement, contrary to traditional teaching methods. Bloom (1976) formulated this model using the degree of learning theory introduced by Carroll (1963). This individual-centered model was adapted and used as a basis for his Mastery Learning paradigm. Current advocates of this methodology continue to praise its results, pointing out the specificity and preci-
sion required in the design of Mastery Learning programs to be an advantage (i.e., exhaustive evaluation techniques, correctives, and enrichments). The attainment of clearly defined goals, prepared much earlier in the instructional process than in conventional teaching, also strengthens this model (Horton, 1981). Mastery Learning advocates have done very little research on student performance in actual game situations. The question to be answered is whether Mastery Learning methodology produces superior performance in the various stages of volleyball game play for all students as Bloom claims.

This study investigated student success using Skill Teaching and Mastery Learning through the various stages of volleyball game play, concentrating on the competitive game. Since self-efficacy and skill level have been found to parallel each other (Harrison, Fellingham, & Buck, 1995), self-efficacy was also assessed.

**Skill Teaching**

In 1990 Buck and Harrison recommended the development of a learning strategy to increase the total number of contacts with the ball and the percentage of successful trials in game play, especially for low-skilled participants. The Skill Teaching model that evolved stresses successful performance of psychomotor skills, first in game-like drills, next in modified games, and finally in game play. The model incorporates factors learned from research on games playing, the recommendations of the U.S. Volleyball Association (USVBA) (Kessel, 1988), and aspects of Mosston and Ashworth's (1994) inclusion style, which allows students to choose their participation level for each skill.

Game play requires complex mental decisions and physical adjustments under pressure. When the needed behavior is too complex or stressful, students substitute alternative behaviors resulting in a regression in motor skills. Barrett (1977) noted that the middle stages of game play are "missed entirely or passed through so quickly as to have no effect" (p. 21). Buck, Harrison et al. (1991) found few skill trials in six-player volleyball games. When games are played, they "must be developmentally appropriate in terms of skills required, complexity of strategy, and opportunity for participation" (Siedentop, Mand, & Taggart, 1986, p. 201; see also Evans, 1980). Rothstein and Wughalter (1987) suggested students should practice all possible skill combinations in less complex situations prior to using them in the game to ensure a smooth transition into game play. Teachers select or create drills and lead-up games that force students to move to the ball, direct the ball to a moving target, or direct the ball to a place different from the point of origin. The key is to simplify the game and then gradually increase complexity until it approximates the official game.

Skill Teaching allows students to choose their practice ball (official or Volley Lite), net height (2 m, women's height, or men's height), and serving distance from the net. Research by Harrison, Buck et al. (1995) showed that students allowed these choices have no difficulty changing to regulation games. Research substantiates more opportunities to respond correctly with small teams (Brown, 1986; Kessel, 1988; Parker, 1984) and more involvement by low-skilled players (Buck & Harrison, 1990; Griffin, 1985). Ball modifications were suggested by Durrwachter (1981) and Lawless (1984). Kessel, representing the USVBA at a 1989 AAHPERD convention, recommended the Tachikara Volley Lite, a regulation-sized and constructed ball lighter in weight than the official ball. The USVBA (Kessel, 1988) also suggested a lower net height.
to help players develop advanced skills such as attacking and blocking. The USVBA (Ferrell & McPeak, 1983; Kessel, 1988) suggests three contacts by each team, no specialization by position, and nonstandard scoring to increase skill development. In an unpublished study by Earls (cited in Parker, 1984), response rates increased by about 50% over conventional game play when three hits were required on a side. Team strategies should not be introduced until students feel secure with the basic skills and individual offensive and defensive tactics.

Mastery Learning

Mastery Learning, as conceptualized by Bloom (1976), is based on the assumption that almost any person can learn when provided with sufficient time and help. "Mastery Learning is based on the premise that learners must acquire skill in incremental, sequential progressions, with prerequisite skills being learned (mastered) prior to attempting more difficult and complex tasks" (Metzler, 1984, p. 64). Bloom’s Learning for Mastery is a group-based, teacher-paced approach. The teacher directs the learning process using the following components and procedures (the first four by Stallings & Stipek, 1986, p. 742; the last by Bloom, 1976, p. 20).

1. Clear instructional objectives with predefined performance standards (set high enough to be challenging, yet attainable) are arranged into subunits, each containing several “learning tasks.” Standards should be set at the level of an “A” student. Each learning task and its performance criterion are stated so teachers and students can determine when a task has been mastered.

2. Frequent formative tests provide feedback about student achievement for each objective and serve as a motivational technique. They also help teachers pace instruction to meet student needs. Formative tests should be as gamelike as possible and be authentic assessments, done in the game, whenever possible.

3. “Enrichments” allow students who master the formative test to practice the tasks at a more challenging level or to help others who have not yet mastered the task. “Correctives” are used to help those not achieving mastery. Enrichments and correctives should be gamelike.

4. Summative evaluation is administered to determine student mastery of unit objectives and to determine grades.

5. Group cohesiveness results from group members working together to achieve a high level of skill, since 80% of the students must master the skills of the first subunit before moving on to the next subunit. As students achieve mastery, they often work with slower learners, which also strengthens their own learning.

Two meta-analyses confirm the effectiveness of Mastery Learning in education. Kulik, Kulik, and Bangert-Drowns (1990), in comparing 108 studies, demonstrated that Mastery programs have positive effects on college, high school, and elementary school students’ examination performance and attitudes toward content and instruction. "The effects appeared to be stronger on the weaker students" (p. 265). Synthesizing 27 research studies in elementary and secondary schools, Guskey and Gates (1986) found positive achievement results, longer retention, less “corrective” time over a series of units, greater positive attitudes about learning and about each individual’s ability to learn, and higher teacher expectations for students. Studies establishing similar positive Mastery Learning outcomes in physi-

**Self-Efficacy**

As students learn physical skills, they form impressions about their own abilities and worth. Self-efficacy, situation-specific self-confidence (Feltz, 1988), is an individual’s conviction that he or she is capable of executing the behaviors necessary to produce a certain outcome (Bandura, 1977, 1986). Dweck and Elliott (1984) found that maximizing self-efficacy helps to create learning opportunities that match task difficulty with learners’ developmental capabilities. Easy tasks give little pleasure, while tasks with goals that are high, yet attainable, help students improve their skills and convey the idea that higher levels of skill are both expected and attainable (Bunker, 1991). As students achieve higher levels of skill, self-confidence grows.

Miller (1993) concluded that self-efficacy varies in response to different task and situational demands in sport. Harrison, Fellingham, Buck, and Pellett (1995) found that self-efficacy scores varied from skill to skill within the same sport. Highly efficacious participants seek out new and challenging situations, intensifying their efforts when their performance falls short of a desired goal (Bandura, 1990). Griffin and Keogh (1982) extended and applied Bandura’s and Harter’s theories to physical education. They defined movement confidence as “an individual feeling of adequacy in a movement situation” (p. 213).

Self-efficacy exerts a significant influence on the performance of unskilled individuals (Feltz, Landers, & Raeder, 1979; Feltz & Mungo 1983; Hogan & Santomier, 1984; Mahoney, Gabriel, & Perkins, 1987; McAuley, 1985). Low-skilled students have lower self-efficacy in golf (Johnson, 1992), swimming (Miller, 1993), basketball (Chase, Ewing, Lirgg, & George, 1994), and volleyball (Harrison, Fellingham, Buck et al., 1995). These results indicate that efficacy plays an important role in the practical world of sport learning and performance. Lirgg (1991), Chase et al. (1994), and Harrison, Fellingham, Buck et al. (1995) found that males had higher self-efficacy scores than did females.

The purpose of this study was to compare the effects of two instructional models, Skill Teaching and Mastery Learning, on student learning or improvement in psychomotor skills, game play, knowledge, and self-efficacy. We were especially interested in the differences in learning among students of various ability levels. Each method had proponents who believed it would produce superior results.

**Methods**

**Participants**

Participants included 182 students (78 males and 104 females) in six beginning collegiate volleyball classes who signed consent forms. Classes met 2 days a week for 16 weeks. All research data were related to assigned numbers for each student. Students were divided into high-, medium-, and low-skilled ability groups for statistical analysis only. This division, based on students’ combined T-scores on four skill pretests; the AAHPERD (1969) set-up, passing, and serving tests, and
the Stanley (1967) spike test, was originally done using 116 students in two previously reported studies (Buck & Harrison, 1990; Harrison, Fellingham, Buck et al., 1955). Originally each group represented 33% of the sample. For consistency of analysis across studies, the same cut-off scores were used. However, in this study the middle group had fewer than one third of the students. The medium-skilled ability group was deleted from this analysis, resulting in data for 147 high- and low-skilled students.

Since previous studies of students in two similar beginning college volleyball classes with no instructional interventions showed no improvement in skill development (Buck, Harrison et al., 1991) or game play (Buck & Harrison, 1990), no control group was used in this study.

**Skill Instruction**

Six beginning volleyball classes were taught by three graduate teaching assistants assigned on the basis of their previous experience playing and teaching volleyball. One of the three instructors had previous experience with the Mastery Learning model. Each instructor taught two classes, one randomly assigned to the Skill Teaching model and the other to the Mastery Learning model. All instructors were trained in the methods of each model. They were given a notebook and instructions for the two methodologies, including lesson plans and modified games, during a workshop before the study began. The two principal researchers (one for Skill Teaching and the other for Mastery Learning) then monitored the instruction daily for the first 3 weeks to ensure compliance with the two methods and then randomly for one of the two class sessions of each method each week thereafter, using a checklist of the major components of each style. For example, the Mastery Learning model used formative testing, while the Skill Teaching model did not. Initial problems resulted in trying to convince the teachers of the importance of the three-player rather than the six-player games in both styles and ensuring that equipment modifications were available for the Skill Teaching classes. Although many of the drills were the same for both models, individual students in the Mastery Learning model chose drills depending on their test results (correctives or enrichments), while students in the Skill Teaching model did all drills together as a class. Table 1 shows the daily instructional sequence, with examples for the various activities.

**Skill Teaching Model.** The forearm pass, set, serve, and spike were taught in a sequence established by Harrison using Rink’s (1993) system of content development. Skills were taught with modified equipment and rules as suggested by the USVBA (Kessel, 1988) in an attempt to increase the successful and total trials of each student. Modifications included half-court Minivolley games, played with three players on a team, with all players functioning as passers, setters, and spikers; nets at 2 m, women’s height, and men’s height; official and Volley Lite balls; and simplified rules, with three contacts required per team and the use of extra points for using the skill being developed. All three teachers followed the same lesson plans. Each class session included a warm-up, skill practice, and modified games.

**Mastery Learning Model.** Mastery classes were taught, using Bloom’s (1976) Mastery Learning techniques, from lesson plans developed by Blakemore, an expert on Mastery Learning in physical education. Students in the Mastery Learning classes completed daily task sheets that included formative testing, “correctives” and “enrichments,” and modified game play. The teaching progression
<table>
<thead>
<tr>
<th>Skill teaching</th>
<th>Mastery learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll call while doing warm-up practice (informal games or partners, etc.)</td>
<td>Formative testing (roll call from test sheets) for each skill previously taught (e.g., receive a toss, then pass to the hula hoop, 20 times).</td>
</tr>
<tr>
<td>Instruction: Demonstration and cues (about 5 minutes). Cues: Arms and wrists together (thumbs parallel), keep rear down, right foot forward, arms away from body. Practice drills (20 min). Redemonstrate and reinforce cues as needed. Examples: 1. Practice toss to partner's extended arms. 2. Toss ball to partner, who forearm passes back to you. 5. Toss ball to side of partner, who forearm passes back to you. Alternate sides. 6. Hit forearm passes back and forth with partner. Add Cue: Face ball (angle arms to direct ball). 10. Triangle—Pass ball clockwise. Pass ball counterclockwise. 11. Shuttle—person in line passes to first person in other line, then runs to the end of the other line. (Keep to the right for safety.) 12. Two-hand toss over net. Forehand pass to target. Retriever rolls ball under net to tosser. Rotate modified games (10 minutes).</td>
<td>Instruction: Demonstration and cues (about 5 min). Cues: Arms and wrists together (thumbs parallel), keep rear down, right foot forward, arms away from body. Work on correctives on task sheets until skill is mastered (mastery = 16), then work on enrichments. Examples of correctives: 1. Toss ball to partner, who forearm passes back to you 5 consecutive times. 2. Toss ball to side of partner, who forearm passes back to you 10 consecutive times, alternating sides. 3. Three people form a triangle. Forearm pass the ball clockwise 10 consecutive times (angle arms). 5. Play minivolley using only the pass. Your team must score at least 10 points. Example of enrichments: 1. Practice correctives with someone trying to master the pass until he or she can complete at least 2 tasks. 3. Receive 20 overhead serves starting in the center back position and return 15 of them, 2 feet above the net, to the setter boxes on the sides of the court. 4. Play 3 minivolley games, executing at least 10 correct passes and winning 2 of these games. 5. Play a regulation volleyball game, executing at least 10 correct passes.</td>
</tr>
</tbody>
</table>
was separated into two subunits. Subunit I included the forearm pass, set, overhead serve, spike with no approach (two step), and Minivolley games. Subunit II included full court games (six on six), 4-2 offense, player up defense (behind the setter), serve receive (U), block, spike with the full approach (four step), and dive/sprawl skills.

Skills Tests

Since these college students had some previous volleyball experience, the AAHPERD (1969) set-up, passing, and serving tests and the Stanley (1967) spike test, selected for their game-like qualities, were administered during the 2nd and 3rd days of class as a pretest and, using the same format, during the 12th and 13th days as a midterm test and the last 2 days of class (Days 27 and 28) as a posttest. The skills tests were used to test learning at the beginning stages of the game-play models. The set-up and pass tests involved tossing a ball to participants who passed or set the ball over a rope into an appropriate area on the floor. The serve test required participants to overhand serve from behind the end line. One to four points were scored depending on where the ball landed. For the spike test, participants spiked the ball against the floor, with a rebound from the wall, for 1 min. The AAHPERD tests were developed to have logical validity with skills used in the official game, with a reliability coefficient of .70 or above. Test-retest reliability (.80) for the spike test was established using 18 male members of an advanced volleyball class. A validity of .64 was obtained by correlating the spike test scores with the sum of the ratings by two experts of 31 male volleyball students.

Self-Efficacy Scales

Skill-related self-efficacy scales (based on the work of Bandura, 1977) were administered following the skill pretest and preceding the midterm and final skills tests. Bandura measured levels of self-efficacy by noting the number of tasks on a list that individuals indicate they can successfully complete. A sample task is "to perform the overhand serve from the service line over the net and into the court in a game situation." The participants indicated whether they could do the task and then marked on a 100-point scale how confident they were that they could complete each task marked yes. The sum of the items the student marked yes divided by the total number of tasks on the list was the measure of efficacy strength (e.g., a score of 300 for a 5-item list = 300/5 = 60). A score of 90–100% indicated high confidence that the student could perform the skill. Test-retest reliability using intraclass correlation was calculated from tests given 1 week apart to 20 students not involved in the experimental classes. Reliability coefficients were .999 for the pass, .998 for the set, .925 for the serve, and .993 for the spike.

Knowledge Test

A knowledge test was administered to all students in the university testing center during the 2 days just preceding the class tournament. This test was included because knowledge is important at each level of skill learning and application. The 63-question objective test was separated into the following three categories: (a) techniques, with 23 questions; (b) rules, with 24 questions; and (c) strategies, with 16 questions. The knowledge test was constructed using a table of specifica-
tions to establish content validity. The Kuder-Richardson (KR-20) formula used to estimate the internal consistency of the test was .7024. Mastery levels were set at 80% for the total test and for each of the subtests.

**Videotape Analysis**

Students were videotaped in regular volleyball games on the 4th and 13th days and during a 6-day tournament on Days 21 through 26. All successful and unsuccessful game trials for each student were tallied each day. The following definitions were used for successful trials:

1. Forearm pass—a ball hit off both forearms directed to a position in which the setter could get under the ball for a good set.
2. Serve—a ball hit overhand that traveled over the net and landed in bounds.
3. Set—a legal hit to the necessary height and position for a spike attempt by a teammate.
4. Spike—a ball contacted above the net and driven downward, landing in bounds on the opponents’ side of the net or touching an opposing player prior to touching the floor.

All four skills were counted each day, and tapes were rewound as needed to tally each student’s trials. Interrater and intraclass reliability coefficients were established by recording all skill and game trials on one complete videotape after an interval of 1 month. The intrarater percentage of agreement was 88.3% for one coder and 90% for the other, while the interrater percentage of agreement was 86%. Each student’s percentage of correct trials for game play was determined by dividing the number of correct trials by the number of total trials for that skill.

To determine the ratio of total passes per serve, the number of total passes (sets or spikes) attempted per day in game play was divided by the number of successful serves executed by all of the students in that class. Total contacts per serve were determined by adding the total sets, forearm passes, and spikes attempted divided by the number of successful serves.

**Statistical Analysis**

A random coefficients growth curve model (RCGCM) was used to analyze the data for the various skills and for self-efficacy for the high- and low-skilled students, leaving out the medium-skilled students. The RCGCM has a long history in the statistical literature (Grizzle & Allen, 1969; Khatri, 1966; Potthoff & Roy, 1964; Wishart, 1938) and is a subset of a richer class of models called linear mixed models. Growth curve models are used to test for learning over time by comparing slopes and intercepts of estimated growth curves for various subsets of subjects. These models appropriately account for the covariance structure that results from taking multiple measurements on individuals. The common model currently in use to analyze RCGCM was proposed by Laird and Ware (1982) and has been implemented by SAS in the Proc Mixed procedure. Unfortunately, while this model correctly accounts for the covariance structure of multiple measures per individual, it is not general enough for the research reported here, since this research has not only multiple measures per individual but also multiple individuals nested in a single instructional group or class. Thus, to account for learning in a classroom setting, the RCGCM must be imple-
mented in a hierarchical setting. The hierarchy in this case is measurements within subjects and also subjects within classes.

To appropriately account for class, as well as subject variability, the extension to hierarchical random coefficient growth curve model (HRCGCM) developed by Fellingham and Wise (1995) was used. This method accounts for the nesting of students within classes and computes appropriate estimates and standard errors for slopes, intercepts, and other covariates of interest. The HRCGCM is based on normal theory, and all tests reported are asymptotically normal. To account for the estimation of the variance components in the tests involving fixed effects, we report \( t \) statistics for all treatment effects. Since tests reported are single-degree-of-freedom tests, these are equivalent to the more commonly reported \( F \) tests from ANOVA. We tested for the effect of skill level, instructional method, gender, and individual instructor on learning. Since instructor was not significant, this term was deleted from all models and is not reported. Each response was tested univariately. The technology to test all response variables simultaneously (a multivariate hierarchical random coefficients growth curve model) does not exist at this time.

ANOVA was used to determine differences in the knowledge test scores and the number of total trials in game play between the Skill and Mastery groups. The significance level for all analyses was set at .05.

Results

The following data will be reported: (a) skill achievement (skills tests), (b) self-efficacy, (c) knowledge, and (d) game play. Although the discussion is concerned with high- and low-skilled students, the high-skilled students were predominantly males, while the low-skilled students were predominantly females. In fact, if gender only were known, 84% of the students could be correctly classified into the high- or low-skilled groups. The medium-skilled group was deleted from the analysis.

Skill Achievement (Skills Tests)

Students improved significantly (\( p < .0005 \)) from pretest to posttest on each of the skills tests (pass, \( t \) [131] = 4.68; set, \( t \) [130] = 3.71; serve \( t \) [130] = 3.43; spike, \( t \) [129] = 4.65) as shown by the scores in Table 2. Although the Mastery Learning students scored higher on all the skills tests, no significant difference existed in the learning slopes between the Mastery Learning and Skill Teaching models for the forearm pass, serve, or spike. The high-skilled students started 1.1 points higher than the low-skilled students on the pass, \( t \) (130) = 1.67, \( p < .05 \); 1.8 points higher on the set, \( t \) (130) = 2.38, \( p < .01 \); 8.5 points higher on the serve, \( t \) (130) = 4.00, \( p < .0001 \); and 5.5 points higher on the spike, \( t \) (130) = 3.13, \( p < .002 \).

A significant difference, \( t \) (130) = 2.53, \( p < .007 \), occurred between the two models on the set. Students in the Mastery group scored approximately 1.3 points higher on the set posttest than those in the Skill group.

Self-Efficacy

Overall the changes in self-efficacy paralleled the changes in skill development with a significant difference, \( t \) (131) = 11.65, \( p < .0001 \), from pretest to posttest as shown in Table 3. Although no significant difference existed between
<table>
<thead>
<tr>
<th></th>
<th>Forearm pass</th>
<th>Set</th>
<th>Serve</th>
<th>Spike</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td><strong>Skill</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>4.4</td>
<td>8.5*</td>
<td>5.3</td>
<td>8.3*</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>3.2</td>
<td>6.2*</td>
<td>3.9</td>
<td>7.5*</td>
</tr>
<tr>
<td>All</td>
<td>3.9</td>
<td>7.5*</td>
<td>4.6</td>
<td>8.0*</td>
</tr>
<tr>
<td><strong>Mastery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>4.3</td>
<td>8.9*</td>
<td>5.2</td>
<td>10.4*</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>3.9</td>
<td>6.9*</td>
<td>3.6</td>
<td>8.4*</td>
</tr>
<tr>
<td>All</td>
<td>4.2</td>
<td>8.2*</td>
<td>4.6</td>
<td>9.7*#</td>
</tr>
<tr>
<td><strong>Both</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>4.4</td>
<td>8.8*</td>
<td>5.2</td>
<td>9.5*</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>3.6</td>
<td>6.5*</td>
<td>3.8</td>
<td>7.9*</td>
</tr>
<tr>
<td>All</td>
<td>4.0</td>
<td>7.9*</td>
<td>4.6</td>
<td>8.9*</td>
</tr>
</tbody>
</table>

*Note. Posttest equals last 6 days of game play.

*p < .0005 for improvement.

#p < .007 for model.
the two models, significant differences did exist between the low-skilled and high-skilled students. The high-skilled students started higher than the low-skilled students on the forearm pass (11 points higher, t[131] = 1.88, p < .032; set, 14 points higher, t[131] = 2.15; p < .017; serve, 21 points higher, t[131] = 2.82; p < .0028; and spike, 15 points higher, t[131] = 1.88; p < .032). The low-skilled students had a steeper slope for the forearm pass, improving just over 9 points more than the high-skilled students, t(131) = 1.73, p < .05. For the set, the low-skilled students improved just over 13 points more than the high-skilled students, t(131) = 2.19, p < .016. For the serve, the low-skilled students improved nearly 11 points more than the high-skilled students, t(131) = 1.87, p < .033. Thus, the scores for the two groups were closer together at the end than at the beginning. No significant difference in slopes occurred for the spike.

The changes in self-efficacy by gender were similar to those for skill level, with significant improvement (p < .0001) from pretest to posttest as shown in Table 3 (pass, t[131] = 6.40; set t[131] = 7.62; serve, t[131] = 7.69; and spike t[131] = 7.73). Males scored significantly higher than females, starting 19 points higher on the forearm pass, t(131) = 3.72, p < .001; 14 points higher on the set, t(131) = 2.15, p < .017; 46 points higher on the serve, t(131) = 7.55, p < .0001; and 15 points higher on the spike, t(131) = 1.88, p < .032. The females had a steeper slope in passing, t (131) = 2.48, p < .008; setting, t (131) = 2.19, p < .016; and serving, t (131) = 3.07, p < .002. There was no difference in slope for spiking. Thus, the scores for the two groups were closer together at the end than at the beginning for most skills.

**Knowledge**

No significant difference existed between models on the knowledge test. The mean was 80% correct. The percentage of students achieving 80% on each subtest in the Skill Teaching classes was 83% on rules, 59% on strategy, 91% on techniques, and 70% on the total test. For the Mastery Learning classes, the percentages were 73% on rules, 54% on strategy, 90% on technique, and 67% overall.

**Table 3** Total Self-Efficacy Scores by Skill Level and Gender

<table>
<thead>
<tr>
<th>Skill level</th>
<th>Pretest</th>
<th>Midtest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-skilled</td>
<td>54.45</td>
<td>70.57</td>
<td>80.25*#</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>34.55</td>
<td>55.30</td>
<td>67.10*</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>67.03</td>
<td>80.07</td>
<td>87.18*#</td>
</tr>
<tr>
<td>Female</td>
<td>29.25</td>
<td>51.35</td>
<td>64.75*</td>
</tr>
</tbody>
</table>

*p < .0001 for improvement.

#p < .0001 for difference between ability groups.
Game Play

The following data reflect the results of the game play analysis: (a) the number of total trials in game play, (b) the percentage of successful trials in game play, and (c) the number of contacts per serve for each of the four skills taught.

Number of Total Trials in Game Play. No significant difference existed in the average number of trials per day between the two models. Overall, the low-skilled students had only about half as many game trials in six-player games as the high-skilled students. The number of trials for the low-skilled students varied from 32.5% as many on the spike and 39.5% on the set to 51.0% as many on the pass and 64.6% on the serve.

Percentage of Successful Trials in Game Play. Students improved significantly (p < .05) from pretest to posttest on the percentage of successful passes, t (115) = 2.18, and serves, t (119) = 2.60, in game play. The set and spike were not significant (see Table 4). A great deal of variability existed among the learners.

There was no significant difference in the rate of improvement in the percentage of successful trials in game play between the Mastery Learning and Skill Teaching models for the forearm pass, set, or serve. For the spike, the Mastery group started 28% age points lower than the Skill group at the intercept, t (212) = 1.68, p < .05, but then improved at a greater rate than the Skill group, t (212) = 1.93, p < .03.

There were no significant differences in the learning slopes between the high-skilled and the low-skilled learners for the pass, set, serve, or spike. The high-skilled students started 21% age points higher than the low-skilled students on the pass, t (514) = 3.56, p < .001; 28.4% age points higher on the set, t (224) = 2.44, p < .008; and 28.3% age points higher on the spike, t (212) = 1.96, p < .03. There was no difference in starting points for the serve (Table 5).

Number of Contacts Per Serve. No significant differences existed between the models or between ability groups on the learning slopes, nor did students improve significantly on the number of contacts per serve.

Discussion

The major finding of this study was that both Skill Teaching and Mastery Learning produce improvement in isolated skills, in self-efficacy, and in some aspects of game play. However, Sweeting and Rink (1999) remind us “achievement scores do not always directly reflect movement content changes and may mask the effects of certain environmental factors on learning motor skills” (p. 218). There were few significant differences between the two models that would substantiate favoring one model over the other for skill instruction. This could mean that neither model is worth using. However, these results compared favorably with the results of students in previous Skill Teaching classes (Harrison, Buck et al., 1995) and were superior to those of students in previous nonintervention classes (Buck, Harrison et al., 1991). Thus, either model appears to be successful in promoting student achievement. A third alternative, of course, is that some other model, such as the Games for Understanding model (Bunker & Thorpe, 1982; Werner, Thorpe, & Bunker, 1996) or Sport Education (Siedentop et al., 1986) might be superior to both of these models.

The results will be interpreted in terms of the stages of game play advocated by Rink (1993). Rink proposed a four-stage process to ready students for partici-
Table 4  Percentage of Successful Trials in Game Play by Model and Ability

<table>
<thead>
<tr>
<th>Skill</th>
<th>Forearm pass</th>
<th></th>
<th>Set</th>
<th></th>
<th>Serve</th>
<th></th>
<th>Spike</th>
<th></th>
<th>Total trials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Pretest</td>
</tr>
<tr>
<td>High-skilled</td>
<td>.356</td>
<td>.441*</td>
<td>.643</td>
<td>.649</td>
<td>.503</td>
<td>.670*</td>
<td>.723</td>
<td>.636</td>
<td>.565</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>.120</td>
<td>.252*</td>
<td>.329</td>
<td>.399</td>
<td>.437</td>
<td>.620*</td>
<td>.539</td>
<td>.542</td>
<td>.335</td>
</tr>
<tr>
<td>All</td>
<td>.247</td>
<td>.356*</td>
<td>.509</td>
<td>.550</td>
<td>.472</td>
<td>.647*</td>
<td>.662</td>
<td>.601</td>
<td>.506</td>
</tr>
<tr>
<td>Mastery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>.385</td>
<td>.447*</td>
<td>.513</td>
<td>.654</td>
<td>.579</td>
<td>.691*</td>
<td>.532</td>
<td>.697</td>
<td>.551</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>.247</td>
<td>.310*</td>
<td>.308</td>
<td>.433</td>
<td>.398</td>
<td>.573*</td>
<td>.611</td>
<td>.618</td>
<td>.378</td>
</tr>
<tr>
<td>All</td>
<td>.337</td>
<td>.399*</td>
<td>.445</td>
<td>.585</td>
<td>.514</td>
<td>.648*</td>
<td>.547</td>
<td>.672#</td>
<td>.517</td>
</tr>
<tr>
<td>Both</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>.373</td>
<td>.446*</td>
<td>.561</td>
<td>.652</td>
<td>.548</td>
<td>.682*</td>
<td>.615</td>
<td>.676</td>
<td>.531</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>.179</td>
<td>.282*</td>
<td>.318</td>
<td>.413</td>
<td>.419</td>
<td>.598*</td>
<td>.566</td>
<td>.587</td>
<td>.394</td>
</tr>
<tr>
<td>All</td>
<td>.295</td>
<td>.381*</td>
<td>.471</td>
<td>.570</td>
<td>.494</td>
<td>.647*</td>
<td>.602</td>
<td>.646</td>
<td>.499</td>
</tr>
</tbody>
</table>

Note. Posttest equals last 6 days of game play.
*p < .05 for improvement.
#p < .05 for model.
Table 5  Total Contacts (Passes, Sets, and Spikes) Per Serve in Game Play by Model and Skill Level

<table>
<thead>
<tr>
<th>Skill</th>
<th>Pretest</th>
<th>Midtest</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-skilled</td>
<td>2.236</td>
<td>2.165</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>0.496</td>
<td>0.780</td>
</tr>
<tr>
<td>All</td>
<td>2.731</td>
<td>2.945</td>
</tr>
<tr>
<td>Mastery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>3.035</td>
<td>3.365</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>0.763</td>
<td>0.896</td>
</tr>
<tr>
<td>All</td>
<td>3.798</td>
<td>4.261</td>
</tr>
<tr>
<td>Both</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-skilled</td>
<td>2.6355</td>
<td>2.765</td>
</tr>
<tr>
<td>Low-skilled</td>
<td>0.625</td>
<td>0.838</td>
</tr>
<tr>
<td>All</td>
<td>3.26</td>
<td>3.603</td>
</tr>
</tbody>
</table>

Note. Posttest equals last 6 days of game play.
*p < .05 for improvement.

pation in games. Stage 1 involves the ability to control the object, including consistently directing objects to a specified place with the intended force; obtaining possession of an object from any direction, level, or speed; and maintaining possession while moving in different ways with different speeds. Stage 2 involves combining skills and adding rules. The focus is on controlling the object in simple game-like play. Stage 3 involves using the skills with simple offensive and defensive strategies in less complex (lead-up) game situations such as three-on-three. Players, boundaries, scoring, and rules can be changed to gradually increase the complexity of the games. Stage 4 consists of sport games, modified at first to keep the play continuous such as by eliminating volleyball serves. At this level students may learn rules, penalties, scoring, and specialized player positions.

Students in both the Skill Teaching and Mastery Learning models improved significantly in their ability to control the volleyball with consistency and efficiency in isolation (Game Stage 1), although as expected, the low-skilled students scored below the high-skilled. This is evident from their skills test scores. In addition, student self-efficacy significantly improved for all students. The knowledge subtest score for techniques demonstrates that 90% of the students had a basic knowledge of skill techniques.

Three fourths of the students passed the volleyball rules test at the 80% level deemed essential for beginning game play. The students also improved in controlling the volleyball in simple game-like play where skills are combined for execution (Stage 2), as shown by their improvement in the percentage of successful passes and serves, the skills used most often in beginning game play. The percentages of successful trials for these students exceeded the percentages for students in the nonintervention study by Buck, Harrison et al. (1991) and were nearly identical to those made by students previously taught with Skill Teaching (Harrison, Buck et al., 1995).
Student success in game play varied considerably between skills, with students experiencing a higher percentage of successful trials on the serve (64.7%) and the spike (64.6%), a lower percentage on the set (57.0%), and the lowest on the pass (38.1%). Considerable differences existed between the high- and low-skilled groups. Overall, the high-skilled group was successful 61.7% of the time, while the low-skilled group successfully executed only 46.4% of their total trials. The largest posttest differences between the two groups were for the set (23.9%) and the pass (16.4%), and the lowest differences were on the serve (8.4%) and the spike (8.9%). Rikard (1991) showed that successful task engagement was 70% for low-skilled students and 86% for high-skilled students in response to isolated instructional tasks. After receiving teacher feedback, low-skilled students increased their practice success to 75%, while the high-skilled students declined to 84%. The low percentages of successful trials in this study for both the high- and low-skilled students reflect the fact that this analysis involved game play rather than skill drills or tests.

Successful trials, in this study, were defined as those contributing to a pass-set-spike sequence. Students need a higher level of skill to perform this sequence, since it is performed in conjunction with other players. Teamwork and experience playing with others, often the same persons, would enhance the results. Silverman, Subramaniam et al. (1998) reported that individual practice, rather than reciprocal or group practice, resulted in more appropriate trials. In addition, skilled players had more appropriate trials, and they would likely be the players executing such a sequence successfully. They concluded that student skill level mediates many teaching effects. Considerations of whether low- and high-skilled students could perform these skills affect the teaching environment. Inappropriate trials may result when low-skilled students attempt to perform these complex game skills. Silverman (1985b) reported less-skilled students may need more time to practice fundamentals. This parallels the mastery learning philosophy. Thus, it might be expected that this group would have more appropriate trials when transferring practice results to the game. However, this was not the case. Although results favored the Mastery Learning group, only skills test scores for the set were significantly better, and this result did not transfer to game play.

Overall the low-skilled students had about one half as many game trials as the high-skilled students, a finding substantiated by Rikard (1991). However, the difference varied by skill, with the low-skilled students having only 32.5% as many spikes but 64.6% as many serves. The number of sets and spikes per day was still rather small, which results in widely varying percentages of success, especially for the low-skilled students. For example, if a student hits only one spike and misses it, his score is 0%, while another player may be successful on her only attempt and score 100%. Even weighting the scores to take into account the number of trials cannot erase the large variability between and within players from day to day. One factor we noticed is that the low-skilled students tend to spike only when they have a good chance to be successful, which tends to raise their percentage of successful spikes. Rikard (1992) theorized that this wide variability may be partly due to inappropriate practice—in other words, progressions that were too difficult. The low-skilled player may not be ready for the complexities of the six-player game. Silverman (1993) noted a positive relationship between appropriate levels of practice and student achievement, and French et al. (1991) reported a deterioration in learning by low-skilled volleyball players when progressions were too difficult.
Silverman (1993) emphasizes using appropriate strategies for low-skilled players to maximize appropriate practice. Such strategies would include reducing task complexity until students are able to perform tasks more successfully. Rikard (1991) suggests incorporating longer units for low-skilled players and challenging the higher-skilled. Once again, Carroll's (1963) model of learning provides a reference point for this study. He includes quality of instruction as a vital factor for student learning success.

The fact that the high-skilled students had approximately twice as many trials in game play leads us to believe that there may be a minimum number of trials necessary for game play improvement. This result corroborates research on the importance of the number of learning trials to achievement (Alexander, 1983; Ashy, Lee, & Landin, 1988; Buck, Harrison et al., 1991; Dugas, 1983; Silverman, 1985a). A minimum level of proficiency may be required before students can utilize their skills effectively in a game situation, with the offensive and defensive strategies that utilize the set and spike (Stage 3).

Only about half of the students understood the strategy needed to complete this knowledge subtest at the 80% level and to play the game competently at a truly proficient level (Stage 4). This is also evident in the game play data for contacts per serve. The total number of contacts (passes, sets, and spikes) per serve increased from the beginning to the end of the semester, but not significantly. The rallies were slightly longer than at the beginning of the semester but still averaged only one pass-set-spike sequence for each serve. When compared with students in the Buck, Harrison et al. (1991) study, these students had one contact more per serve, similar to the gains made by students previously taught with Skill Teaching (Harrison, Buck et al., 1995). As noted before, these are beginning players, and proficiency in game play may not be expected in one semester of instruction.

The low-skilled students improved more quickly in total self-efficacy. Self-efficacy scores at the end of the semester were similar among all students. Although the low-skilled students started at a lower level, they had a greater rate of change in self-efficacy, except on the spike. Since low-skilled students started lower, there was more room for improvement. As performance scores increased, so did self-efficacy scores. Bandura (1977) postulated that personal performance accomplishments are generally considered to be the strongest, most lasting source of self-efficacy. Research performed by Miller (1993) and Chase et al. (1994) demonstrated a direct relationship between efficacy strength and quality of performance.

In this study males had higher performance scores and self-efficacy scores than females. Lirgg (1991) and Chase et al. (1994) found gender differences in self-efficacy similar to those found in this study. Lenney (1997) proposed that females display lower self-confidence when the task is male-oriented or competitive/comparative in nature, or when feedback is ambiguous. In a 1996 study of student beliefs by Lee, Belcher, Friedenburg, and Cleveland (as cited in Lee, 1997), volleyball was judged appropriate for both males and females. The lower self-efficacy may reflect the competitive aspects of the game, as well as the lower performance by females. In this study 96.5% of those in the low-skilled group were females, while only 25.9% of the high-skilled group were females, a finding substantiated by Silverman (1993). A contributing factor to the gender findings is the differences in physical development between males and females. On average, women can produce only 60–80% as much force as men. The largest difference is in arm and shoulder strength rather than trunk or leg strength (Asmussen, 1973). As a result,
males have greater strength to perform the serve and spike. Socialization also leans in favor of males (Haywood, 1993). Significant people (family members, peers, and teachers) encourage or discourage participation in sport activities and provide environmental situations (space and equipment) for sport participation. Often boys are socialized into more active roles in sport and receive greater opportunities to learn skills. Perhaps because of the influence of people and environments, males believe they have greater ability, resulting in positive expectations of success, while females’ beliefs result in negative expectations for success. These beliefs and expectations are reinforced through actual sport experiences. Teachers must be aware of this socialization and help young women experience success and develop self-efficacy.

Rikard (1991) noted that high-skilled students lost interest in practicing simple tasks and needed the challenge of more complex refinement and application tasks. We believe the use of inclusion principles allowed the high-skilled students to select tasks at the appropriate levels of difficulty—net heights, serving distance—while attempting to refine their skills to improve accuracy of placement and technique.

The lack of significant differences between the styles was undoubtedly because both models are direct models in which students receive a similar number of learning trials. French et al. (1991) found that students who practiced the tests did not do better than those who practiced in drill progressions. In this study, students in the Mastery Learning model who took formative tests, performed corrective and enrichment activities, and progressed together as a group did not learn better than students in the Skill Teaching group who performed the same drills together as a group.

This study was done with college-age students (young adults), and the results are most applicable to students in this age group. However, putting genetic and environmental factors aside, motor learning research (Gallahue & Ozmun, 1995) suggests four motor development stages. The specialized movement phase, which is the last of these stages, would be acquired by the average young person by age 14. This suggests that experience must be taken into account when transferring results to younger populations, but general findings pertaining to gender and skill level should be applicable to junior and senior high school students as well.

Metzler (1992) indicated that the real question is not whether one model is better than the other, but rather, “What is the best way to implement a method to maximize its unique features for teachers and students?” (p. 158). In this case, we learn that students can improve significantly with either model, as long as it creates a positive learning environment for a particular student. Ennis and Zhu (1991) found that 92% of teachers make curricular decisions based on their belief systems. The question is, “Which model can the teacher use effectively to help specific students?” Both the Skill Teaching and the Mastery Learning models have clearly defined and delineated skill progressions, creating a positive atmosphere for student learning that agrees with the game play models and with previous research. Another factor that we considered important is the fact that graduate teaching assistants were able to implement both models in such a way as to produce learning gains by the students in their classes. The results of this research agree with Kulik et al. (1990) in that procedure, course content, and instruction may be responsible for skill improvement rather than a particular model of teaching. However, whatever model is used, it is important to provide sufficient game play trials,
especially for the low-skilled students. Instructors should use game-like drills and
modified three-on-three games to give students more trials at appropriate practice
levels before implementing six-on-six games.

We recognize some inherent weaknesses in studies of this type. For example,
in intact classes students are not randomly selected into treatments. Also, using
only two classes per teacher, one of each type, decreases the statistical power of
the analysis. We still believe, however, that assessing all students in an intact class
is a more realistic measure of student performance than assessing only a few stu-
dents in many classes. Future research should continue to concentrate on game
play, rather than drills, in classes continuing for a substantial time period with a
large database.

Future research might look at legal as well as successful trials. It may be that
more improvement is occurring in game play than we were able to code using only
trials that lend themselves to a pass-set-spike sequence.

References

Alexander, K. (1983). Beyond the prediction of student achievement: Direct and repeated
and technique. In W. Kroll (Ed.), Abstracts of research papers—1984 (p. 12). Reston,
nique to achievement in a motor skill. Journal of Teaching in Physical Education, 7,
115-120.
191-215.
128-163.
Education and Recreation, 48(7), 21-24.
Blakemore, C.L. (1985). The effects of mastery learning on the acquisition of psychomotor
Blakemore, C.L. (1986, May). The effects and implications of teaching psychomotor skills
using mastery learning techniques. Paper presented at the International Conference
on Research in Teacher Education and Teaching in Physical Education, University of
British Columbia, Vancouver.
sion of students taught basketball skills using mastery learning and non-mastery learning
tional Research, 57, 507-508.


**Acknowledgment**

We would like to express our appreciation to the following graduate students who worked on this study: Chad Anderson, Tresa Hamson, Brent Nelson, Janette Olsen, Jason Slack, and Julia Taylor.