Changes in Badminton Game Play across Developmental Skill Levels among High School Students

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Abstract

The study examined changes in badminton game play across developmental skill levels among high school students in a physical education setting. Videotapes of badminton game play of 80 students (40 boys and 40 girls) in the four developmental skill levels (each skill level had 10 boys and 10 girls) were randomly selected from a database associated with the South Carolina Physical Education Assessment Program. An observational instrument was developed to code and compare components or categories of badminton skill and tactics used among participants across the four developmental skill levels. Descriptive statistics (mean, SD, and percentage) of occurrence in skill/tactic components and sub-components were calculated for each skill level and compared among the four skill levels. The results revealed clear stages or changes in student badminton performance across different developmental skill levels. The results also indicated that, while students' performance progress were observed when the skill level became higher, students used a large portion of immature serves and strokes across all the skill levels, and the rates of using standard serves and strokes, forceful stroke, and return to home base were low. Performing immature forms of sports skill may be a widely existing but ignored phenomenon in the physical education setting and needs more investigation.

Key words: motor competence, performance, strokes, changes

Sports and games have historically been an important part of physical education curricula, especially at secondary levels. Helping students develop motor competence has become a primary goal of physical education programs (National Association for Sport and Physical Education, 2004). The significance and implication of motor skill acquisition is far beyond the scope of discipline mastery and lies heavily on the potential to facilitate children's lifespan physical activity participation (Centers for Disease Control and Prevention, 2000; U.S. Department of Health and Human Services, 2001). Motor skill level is identified as an enabling factor of youth physical activity participation (Welk, 1999), and youth who are skilled are considered to be more likely to get involved in physical activity as opposed to those with poor motor skills (Okely, Booth, & Chey, 2004; Okely, Booth, & Patterson, 2001). Conversely, those with poor motor performance are more likely to be excluded from games, resulting in a vicious cycle of decreasing physical activity participation (Bluechardt, Wiener, & Shephard, 1995). If developing motor competence is important to levels of physical activity, it is critical for physical educators to understand how to help students develop motor skills and how sports and games should be taught.

Researchers in motor development and motor learning have used different models, such as the stage model and the expertise model, to study the development of motor skills (Thomas, Thomas, & Gallagher, 1993). For example, by applying stage theory, researchers in motor development have extensively studied developmental sequences for fundamental skills such as throwing (Roberton, 1977, 1978), hopping (Halverson & Williams, 1985), and catching (Strohmeyer, Williams, & Schaub-George, 1991). According to Barrett, Williams, McLester, and Ljungkvist (1997), developmental sequences are defined as "descriptions of the series of changes in motor skills (i.e., developmental levels or steps) from their initial attempts to their most advanced performance" (p. 469). One way to study developmental sequences of motor skills is the component approach proposed by Roberton (1982) in which steps or levels of the individual components of the body are identified.

A limited number of studies have examined developmental sequences for sport specific skills. While studying developmental sequences for the overhead tennis serve, Messick (1991) examined six body component actions of the serve. The researcher found that developmental sequences for the preparatory trunk, elbow, and forearm/racket actions met the prelongitudinal screening criteria proposed by Roberton (1978). Additionally, Barrett and her colleagues (1997) investigated developmental sequences for the vertical cradle in lacrosse. In the study, they examined seven body component actions including basic rhythm, hand and arm action, stick position, top hand grip, stick head and top arm action, position of hands, and bottom arm and hand action and concluded that developmental sequences for the vertical cradle in lacrosse existed; however, only some of these body components were observed. In addition, they suggested that both the quality and amount of instruction should be considered when studying developmental sequences for sport specific skills. This is because "the traditional age relationship used to hypothesize sequences (for skills specific to a sport) was not as helpful as when sequences for a fundamental motor skill were being validated" (p. 487). In other words, while validating the developmental sequence for sport specific skills, students' experience and opportunity to learn the skills are critical.

The expertise model has also been used to investigate the development of motor skills. Researchers typically compare performance of skills and knowledge between novices and experts using the expertise model. For example, French and Thomas (1987) found that, compared with young novice basketball players, young expert players exhibited superior basketball knowledge and skills and both cognitive knowledge and motor skills influenced their basketball game performance. Additionally, they suggested that opportunity for learning basketball knowledge and skills might be more important than one's age in developing game play ability.

Guided by the expertise model, Blomqvist, Luhtanen, and Laakso (2000) examined the differences in badminton game performance and game understanding between young expert and novice badminton players. After measuring players' levels of individual skill components (serve, clear, drop, etc.), game performance (total amount and average length of shots, total distance travelled, etc.), and game understanding (responses to game videos), Blomqvist and colleagues found that, compared with novice badminton players, expert players exhibited significantly better skill levels in long serve and clear; performed significantly more shots, longer shots, backhand shots, and travelled significantly longer distance; and demonstrated better game understanding. The findings have provided valuable information in understanding how children and adolescents develop skills and knowledge related to badminton game play.

Physical education scholars have also been interested in how games and sports should be taught. Vickers (1990) proposed the Knowledge Structures (KS) Model to teach sports and games. This model contained eight modules: creating knowledge structures, analyzing learning environment, analyzing learners, developing a scope and sequence, writing objectives, determining evaluation, designing learning activities, and making real–world applications. Guided by the KS model, a series of textbooks in teaching sports and games such as Badminton: *Steps to Success* (Grice, 1996) have been published.

One of the strengths of the KS model is that it clearly and comprehensively presents the factors critical for the sports and games. For example, Vickers (1990) suggested in teaching students badminton the psychomotor skills/strategies should be taught including the indicators of grip, pronation and supination, underhand and serves, footwork, forehand overhead, backhand overhead, strokes to the net, and strokes to the sidelines. Under the indicator of the forehand overhead, there were several sub-indicators of clear, drop, and smash. For the stroke of clear, it included several types of clear: defensive, attack, and around the head. Although the KS model may help teachers better understand the skills and strategies related to badminton game play, the model fails to present developmental sequence, or changing processes of game play ability. The KS model only describes advanced levels of skills and strategies in badminton game play, but does not describe the process through which students may move from an initial stage to a more advanced stage. As a result, limited knowledge is available regarding how students develop game play ability from an initial learning stage to a relatively advanced stage. Therefore, the purpose of this study was to examine the stages of learning in playing badminton across developmental skill levels. Specifically, the study was designed to address the following questions: How did student performances in badminton games change across developmental skill levels? What stages of learning to play badminton might badminton beginners experience? Badminton was selected for the content area in the study because it has been identified as a lifelong game (Samuel, 1991) and is a popular physical education activity in middle and high schools (Ross, 1994).

This study is significant for two reasons. First, knowledge of changes in developing game play ability is a critical part of pedagogical content knowledge in physical education. Like the knowledge of developmental sequences for fundamental and sport specific skills, the knowledge of changes in developing badminton game ability may help teachers see the big picture of how students move from a lower skill level to a higher level of performance in badminton. Second, understanding the changing process of learning game skills and tactics in badminton may allow teachers to better develop instructional strategies. This may serve as a tool to help teachers better observe, assess, and interpret student performance in badminton, and identify what should be taught next in teaching effective badminton play. Identifying where students are in a skill and what is likely to be the next level of development will facilitate developing appropriate tasks for the students. In short, this study may contribute to the knowledge base in teaching badminton and teachers may benefit from the study by designing better learning experiences for students.

Method

Participants

The participants were 80 high school students (40 boys and 40 girls) whose performances of badminton game play were previously videotaped. The videotapes containing the participants' performance were randomly selected from usable videotapes of 300 students in 16 high schools located in South Carolina in the United States. All these videotapes belonged to a database associated with the South Carolina Physical Education Assessment Program (SCPEAP), which was a statewide assessment initiative to assess the effectiveness of school physical education programs. The high school assessment program of the SCPEAP included several performance indicators, and one of them was "demonstrating competency in at least two movement forms." To assess the extent of competency in badminton game play, high school students in South Carolina in the United States were videotaped for their badminton game play at the end of their badminton units.

The assessment task in badminton was "to play a modified game of singles badminton with some evidence of offensive and defensive play and good techniques" (South Carolina Alliance for Health, Physical Education, Recreation and Dance [SCAHPERD], 2000, p.14). The protocols provided by SCPEAP for filming students' performance of badminton game play suggested, "One camera (preferably elevated) should be sufficient to capture play on each side of the court, filming from the side" (SCAHPERD, 2000, p. 14). Physical education teachers who participated in the assessment program videotaped and scored student badminton performance with a rubric developed by SCPEAP. Students were given an overall score from 0 to 3 based on their performances in the games. The accuracy and the reliability of the badminton performance scores submitted were examined by a panel of SCPEAP experts through a monitoring process to make sure that the score given matched the performance level. These experts took 10% of the performance scores and examined the inter-observer agreement of the submitted scores, and only the inter-observer agreement of the submitted scores above 80% was acceptable. More detailed information regarding the SCPEAP and the relevant data collection protocols are available in a monograph published in *Journal of Teaching in Physical Education* (Rink & Williams, 2003).

A stratified selection of the participants from the useable videotapes was used for sampling. Specifically, all of the 300 potential participants were first grouped by their skill level and gender, and then each participant in each group was assigned a number-name. A random number table was used to select 20 participants (10 boys and 10 girls) from each of the four skill levels associated with the 0-3 scores, totaling 80 participants. Participants who were originally scored 0 in the SCPEAP were in Level 1, the lowest level; those with an original score of 3 were put in Level 4, the highest level. The other two skill levels with a score of 1 or 2 were named Level 2 or Level 3 accordingly.

Observational Instrument

An observational instrument used to analyze badminton game performance was developed in four phases. In the first phase, a narrative technique was used to identify all possible badminton skill components in participants' badminton game play. Specifically, the first author spent approximately 100 hours examining the videotaped performance of badminton games and took notes on how the participants performed all types of serves, strokes, shuttle trajectories and landings, and foot movements. The narrative technique is an initial step in developing categories or components of specific sports skills for the purpose of further developing an efficient observational instrument (Thomas & Nelson, 1996).

In the second phase, a conceptual model (see Figure 1) containing all possible badminton skill components that participants might use in badminton play was developed based on the observations and detailed notes taken in the first phase (narrative technique). The model served as a guideline to categorize and analyze badminton skill components observed among participants.

The third phase was to define all the badminton skill categories in the model and develop a coding sheet to code these skill categories. Strict and clear definitions of all the relevant skill categories were essential to achieve reliability of the observational instrument. For those common serves and strokes such as long serve, short serve, drive serve, clear, drop, drive and smash, their definitions were found in badminton textbooks (e.g., Grice, 1996). The definitions of the incorrect, immature, and developmental serves and strokes that occurred among participants but were not addressed by textbooks were made and are presented in Table 1.

In the final phase of instrument development, three steps were used to validate the observational instrument. The first step was to establish the content validity of the instrument. Three experts who taught badminton at the college level or who conducted extensive research in badminton were invited to review the badminton skill components included in the conceptual model. In the second step, the instrument was used to differentiate the skill levels of badminton game play between a group of college students who regularly played badminton games and a group of high school students who were beginning players. The results indicated that the instrument was able to distinguish skill levels between the two groups. A similar procedure to examine construct validity of the observational instrument in badminton was used in a previous study (Blomqvist, Lutanen, Laakso, & Keskinen, 2000).

The last step to validate the instrument was to examine the inter-observer agreement when coding badminton skill categories with the instrument. A research assistant who regularly played badminton and had good knowledge in badminton was trained to

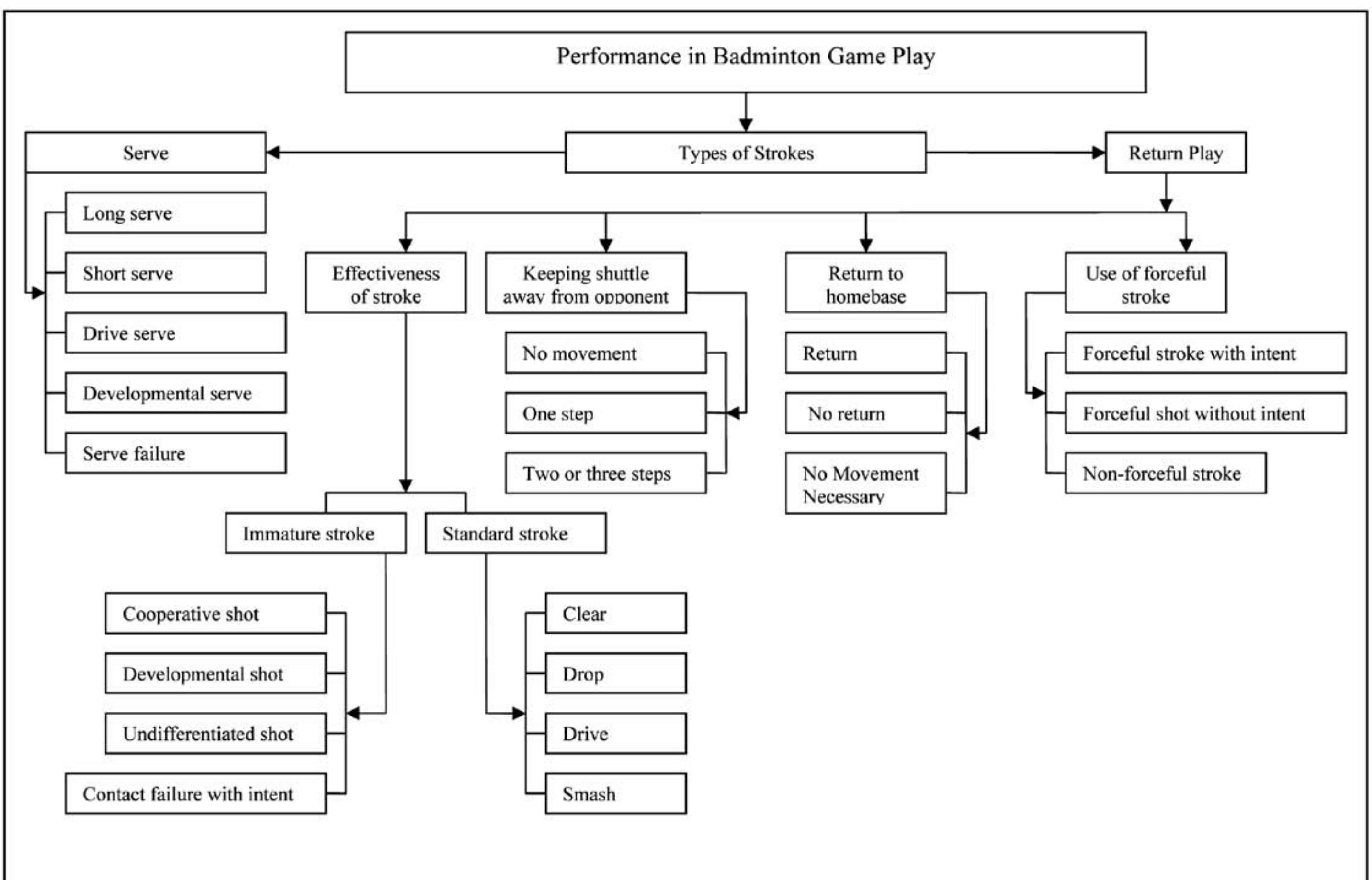

Figure 1. Conceptual Model for Categorizing and Analyzing Performance in Badminton Game Play.

Table 1. ***Definitions of the Immature Badminton Skills and Tactics***

Indicator & Sub-Indicator	Description
Serve	
Sever Failure	A shuttle into the illegal service area, including a shuttle going into the net, out of the service area, or a failure contact of the shuttle.
Developmental Serve	A serve that cannot be categorized as a Long Serve, Short Serve, or Drive Serve. With a Developmental Serve, the shuttle typically lands either in the front or middle service areas with a high trajectory that provides opponents with good opportunity to smash.
Return play	
Contact Failure with Intent	A movement in which a student fails to contact the shuttle with a racket in an attempt to return a shot hit from his/her opponent.
Undifferentiated Shot	A shot is performed with an awkward and odd form. The intent of the shot is not clear and the shot cannot be categorized into Clear, Drop, Drive, Smash, Cooperative Shot, or Developmental Shot. Typically, this shot is executed in a poor body position.
Cooperative Shot	A shot is performed in hitting the shuttle toward an opponent with a relatively slow speed and a high trajectory. Typically, the shuttle is placed in the center of the court.
Developmental Shot	A shot is performed with an observable intent to perform any of the strokes of Clear, Drop, Drive, and Smash, but the execution of the shot is not effective and exhibits some problems in controlling the trajectory, placement, or power of the shot.
Return to Home base	A movement that a student immediately takes at least one step to move to the center of the one's half court after serving or hitting the shuttle back to his/her opponent (the behavior must occur before the opponent hits the shuttle back).
Use of Forceful Stroke	
Forceful Stroke with Intent	Use of a force strokes like the Smash and Drive to give opponents little time to return the shot. Intent in the forceful stroke must be observable.
Forceful Shot without Intent	Use of a shot that is typically hit very hard, but the intent of the shot cannot be identified. An awkward form of the shot is often observed and the shuttle hit usually goes into the net or out of the boundary.
Non-forceful Stroke	Use of a stroke that is performed without much power. Obviously, those who use this shot make no attempt to use forceful strokes to win point in return play.
Keeping Shuttle Away from Opponent	
No Movement Needed	A shuttle is placed close to an opponent who is able to reach and return the shuttle without moving his/her body.
One Step	A shuttle is placed away from an opponent who needs to take one step to reach and return the shuttle.
Two or Three Steps	A shuttle is placed away from an opponent who needs to take at least two or three steps to reach and return the shuttle.

use the coding system. On completion of the training, the assistant and the first author independently coded 20 student performances in badminton games and the inter-observer agreement on each badminton category ranged from 81.2% to 89.8%.

Data Collection and Analysis

Copies of the videotapes of participant performance in badminton game play (n = 80) were made from the SCPEAP database. Permission for using the videotapes for the research was obtained from SCPEAP. The coding sheet, including all badminton skill categories for which the definitions were clearly made, was used to code the videotaped performance of game play. The original videotaped badminton game play for each student lasted 10 minutes, and a clear view of badminton performance for a participant was only available for five minutes when he/she faced the camera. Additionally, in this five-minute clear view there was a large range in the number of hits in return play among the participants. To standardize the analysis procedures, the badminton performance of each student was coded for five minutes or 20 return hits, whichever came first. The first author examined the reliability of the data by randomly selecting 10 participants, re-coding their performance of the game, comparing the coding results with the prior coding results, and computing the intra-observer agreement. The intra-observer agreement in each category ranged from 86.6% to 93.5%.

Descriptive statistics were used to report the performance patterns of badminton game play across the skill levels. The percentage of occurrence of each skill category for each participant was computed by using the total number of frequency of the skill category divided by the total number of return hits (or serves) performed by the participant. For example, for participant A, the percentage of the long serve was computed by using the number of the long serve divided by the total number of serves participant A performed. Percentage mean and standard deviation for each skill category were then computed for each developmental skill level and used to describe student performance in badminton game play (e.g., French, Werner, Rink, Taylor, & Hussey 1996).

Results

Serve

Serve performance of serve failure, developmental serve, short serve, long serve, and drive serve across the four developmental skill levels are presented in Figure 2. The serve failure constituted 70% of all the serves at Level 1, and dropped considerably to 29.3% at Level 2. The developmental serve was observed with the second highest occurrence (27.3%) at Level 1, and increased to the largest percentage (more than 40%) at Levels 2 to 4. As the students moved to higher skill levels, they began to use the short serve, which appeared with 1.7% occurrence at Level 1 and steadily increased to18.5% at Level 4. The long serve was observed with less than 5% occurrence at Levels 1 and 2, and rose sharply to almost 20% at Levels 3 and 4. As for the drive serve, the most challenging serve observed, it appeared with the lowest percentage across the four developmental skill levels, ranging from 0.5% to 5.8%.

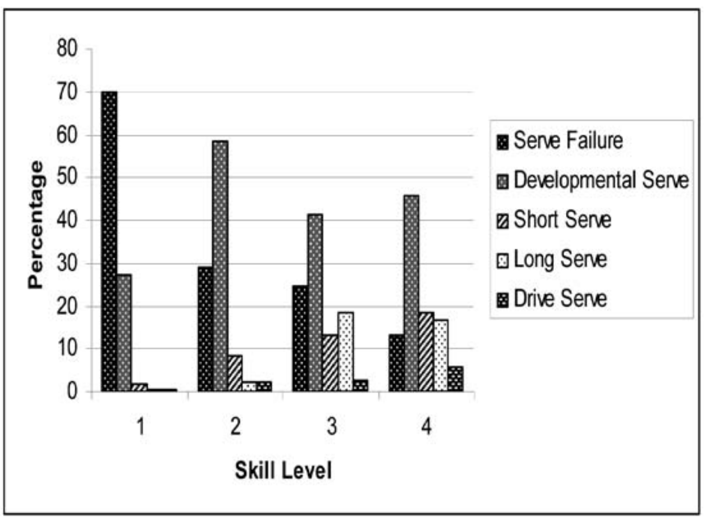

Figure 2. Percentage of Occurrence in Categories of Serve across Skill Levels.

Stroke in Return Play

Stroke in return play included the following five categories: immature stroke, standard stroke, shuttle away from opponent, use of forceful stroke, and return to home base. The results of the five categories are presented as follow.

Immature Stroke. Immature strokes observed in this study contained contact failure, cooperative shot, undifferentiated shot, and developmental shot. Figure 3 presents percentages of occurrence in these immature strokes across the skill levels. Results indicated that the rate of the contact failure decreased from 25.1% to 9.6 % as the skill level enhanced from Level 1 to Level 4, but remained the second highest occurrence among the four immature strokes across all skill levels. Cooperative shot and undifferentiated shot followed the same pattern, decreasing from 13.1% to 2.3% and 18.3% to 6.2% from Level 1 to Level 4, with the cooperative shot occurring at the lowest rate across the four developmental skill levels. As for the developmental shot, it was the most frequently used immature stroke across the four skill levels. Students at Levels 2 and 3 used more developmental shots in the games with 37.1 % and 34 %, respectively. Even at Level 4, 26.8% of the strokes were categorized as a developmental shot. Finally, it was noticeable that the four immature strokes comprised the majority of the strokes in return play at Level 1 (86%), Level 2 (71%), and Level 3 (56%), and it was not until at Level 4 that the students decreased the immature strokes to less than half (45%).

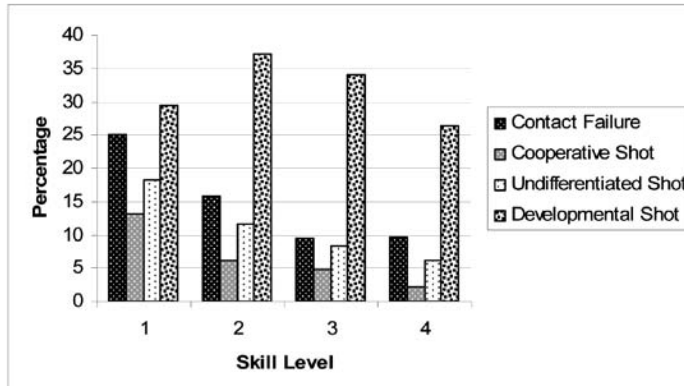

Figure 3. Percentage of Occurrence in Categories of Immature Stroke across Skill Levels.

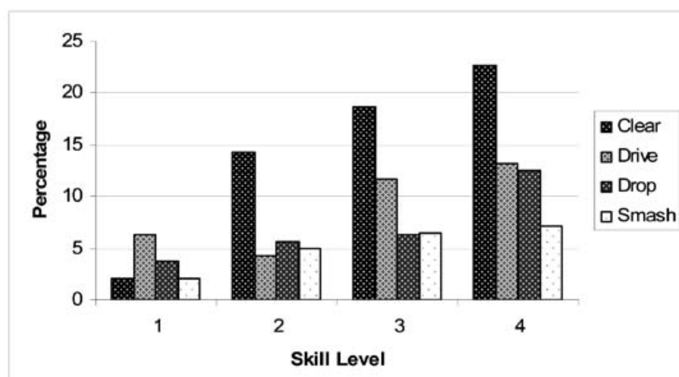

Figure 4. Percentage of Occurrence in Categories of Standard Stroke across Skill Levels.

Standard Stroke. Four sub-categories were under this category: clear, drive, drop, and smash. All of the four standard strokes appeared at Level 1 with very low rates, ranging from 2% to 6.3%, and increased with different patterns as the skill level moved higher (see Figure 4). Specifically, the use of the clear increased sharply from 2% at Level 1 to 14.3% at Level 2, and continued to increase steadily at Level 3 (18.7%) and Level 4 (22.7%). In fact, the use of the clear constituted the largest portion among the four standard strokes at Level 2 to Level 4. The use of the drive remained low at Level 1 (6.3%) and Level 2 (4.3%), and then rose considerably to 11.7% at Level 3 and 13.2% at Level 4, the second highest at these two skill levels. The drop experienced a small increase in the rate of use from 3.7% at Level 1 to 6.3% at Level 3, and increased suddenly to 12.5% at Level 4. As for the smash, the use of it increased slowly at each higher level. When Level 4 was reached, the smash still remained low in its use rate (7.2%), the lowest rate among the four standard strokes at Level 4.

Keeping Shuttle Away from Opponent. This category contained three sub-categories: no movement needed, one step (away from the opponent), and two or three steps (away from the opponent). As shown in Figure 5, students gradually increased placing the shuttle two or three steps away from an opponent (39.6 to 56.4 %) as they moved from Level 1 to Level 4. The other two sub-categories (no movement needed and one step), however, represented a decreasing pattern.

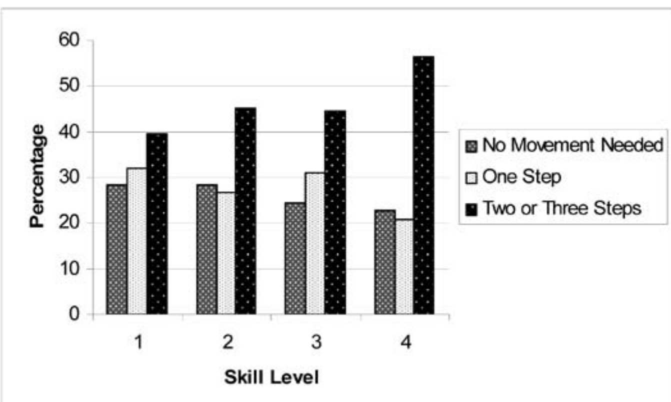

Figure 5. Percentage of Occurrence in Categories of Keeping Shuttle Away from Opponent across Skill Levels.

Use of Forceful Stroke. Results suggested that the majority of the students used non-forceful stroke at Level 1 (87.7%), Level 2 (87.3%), Level 3 (80.6%), and Level 4 (79.6%). The students gradually increased the use of forceful stroke with intent from 8.3 to 20.4 % as they moved to higher skill levels. A slight decrease in the use of forceful shot without intent (4.0 to 1.2 %) was observed as students moved from Level 1 to Level 3. No student at Level 4 used any forceful shot without intent.

Return to Home Base. As skill levels moved from low to high, participants rapidly increased the rate of returning to home base. Specifically, participants returned to their home base with a rate of 1.7% at Level 1, 23.8% at Level 2, 40.5% at Level 3, and 45.7% at Level 4, respectively. The largest progress was made between Level 1 and Level 2. However, even at Level 4, more than 50% of the time participants failed to return to their home base after hitting the shuttle.

Discussion

This study examined specific student performance changes in badminton game play across different developmental skill levels. We intentionally use *developmental skill levels* across the entire manuscript to send the message that all participants in this study, regardless of skill levels, were beginning learners in badminton. Therefore, the information provided here is unique in helping physical education teachers understand changes of performance in learning badminton game play among beginners, thus facilitating these changes in badminton teaching.

The results indicate that, when learning the serve, high school beginning learners experienced a frustrated period at Level 1 in which they frequently (70% of the serve) failed to place the shuttle into legal service area or could not get the shuttle to go over the net (serve failure). This frustration, however, reduced largely at Level 2 (less than 30% of the serve). In addition, when the serve failure dropped after Level 1, the students most frequently used the developmental serve, defined as one that lands in the front or middle service area with a high trajectory providing opponents with a good opportunity to smash, across all the subsequent skill levels. In contrast, while the use of *standard* serves (short serve, long serve, and drive serve) increased with enhanced skill levels, there was limited use of these serves across the four levels, especially the drive serve.

For implications, the first instructional objective in the serve could be to help students place the shuttle into the legal service area. In other words, the use of the developmental serve should be encouraged even if it is an immature serve and never introduced in any textbook. The developmental serve is the easiest way to allow badminton beginners to hit the shuttle over the net and into the legal service area, allowing students to experience a sense of success and gain motivation. Furthermore, the developmental serve is the first prerequisite for badminton game play to begin for beginners, and a necessary transition to mastering any standard serve. We suggest that physical education teachers formally introduce the developmental serve in their badminton units before or when introducing standard serves, and that the developmental serve should be allowed as a major serve format across the entire badminton unit for a large portion of students.

With respect to the standard serves such as the short serve, long serve, and drive serve, their use could be very limited in general physical education classes based on the findings of this study. Many students might not be able to master standard serves, especially the drive serve, even at a late stage of a badminton unit. It will remain a challenging task for physical education teachers to deal with how to facilitate the transition from the developmental serve to the standard serves in the physical education class. In addition, when teaching standard drives, we suggest teaching them in the sequence of short serve, long serve, and drive serve based on the findings of the study.

The findings of the study also reveal that the most frequently used strokes in return play were immature strokes (contact failure, cooperative shot, undifferentiated shot, and developmental shot) among the beginning learners. It is encouraging, however, that the developmental shot, the most “mature” shot in the immature stroke category, occurred at the highest rate across all the four skill levels. It is also encouraging that the occurrence of the other three immature strokes (contact failure, cooperative shot, and undifferentiated shot) obviously dropped when the skill level was enhanced. In addition, the sequence of occurrence (from high to low) for these three immature strokes across all the skill levels was the same: contact failure, undifferentiated shot, and cooperative shot. While previous research reported that high school students extensively used cooperative play in badminton games (French et al., 1996), the cooperative shot had the lowest occurrence among the immature strokes in this study. It is possible that the participant performance was videotaped during game play and the participants made efforts to win in this study, thus using the cooperative shot at a very low rate. This could also account for the high occurrence of the developmental shot found in this study, the shot that was most close to any standard stroke (clear, drive, drop, or smash).

On the other hand, the findings show that the incidences of using the standard strokes in return play was very low, especially at Level 1 and Level 2, and did not go over 50% in the return play until Level 4. With respect to specific standard strokes, students did not show a great gain in the use of the clear until they reached Level 2, the drive until Level 3, and the drop until Level 4. As for the smash, the most challenging stroke observed in return play in the study, it remained a lower rate even at Level 4. The data suggest that it may take a while for badminton beginners in the physical education class to be able to use standard strokes more frequently.

For implications, physical education teachers may want to be tolerant, even encourage, the use of some immature strokes (again, none of them are likely to be introduced by physical education teachers or in textbooks), especially at an early stage of instruction. Based on the findings, the cooperative shot and undifferentiated shot are the most initial levels of *successful* strokes in return play. The developmental shot, an attempt with an observable intent to perform any of the standard strokes (clear, drop, drive, or smash) but also with poor control in trajectory, placement, or power, is the last stage of transition to standard strokes. The use of the developmental shot could be considered as a basic indicator of teaching effectiveness or student learning outcomes before significant gain of any standard strokes in return play occurs.

Another implication is based on the finding that students increased the use of standard strokes in badminton game play in the following order: clear, drive, drop, and smash. This order is consistent with the findings reported by Blomqvist, Luhtanen, and Laakso (2000) that the novice youth players extensively used the clear in badminton games, whereas the expert players more frequently used the drop and smash. Thereby, we suggest that physical education teachers teach standard strokes in this same order, and estimate teaching effectiveness or student performance level based on the occurrence of clear, drive, drop, and/or smash.

In addition to the serves and strokes in return play, the study also produced the findings in shuttle placement (keeping the shuttle away from opponents) in return play, use of forceful stroke with the drive or smash, and return to home base after stroking. With respect to keeping the shuttle away from opponents, the findings are very different from those of serves and strokes in that *mature* tactics were observed most frequently across all the skill levels. Specifically, keeping the shuttle two or three steps away from opponents occurred at the highest rate across all the skill levels with an increasing trend with each higher level, and one step away and no movement needed occurred at the rates lower than two or three steps away with a decreasing trend with each higher level. We would like to interpret this phenomenon as something unintentional, for the most part, rather than intentional for the following reasons.

First, it is not logical for a large portion of the badminton beginners to demonstrate mature tactics in shuttle placement with intended control during beginning stages of learning (including Level 1), especially when they most frequently performed immature serves (serve failure and developmental serve) and immature strokes in return play (contact failure, cooperative shot, undifferentiated shot, and developmental shot) at the same time. Secondly, of the four immature strokes, the developmental shot occurred at the highest rate. Again, the developmental shot was defined in this study as a shot with an observable intent to perform any of the standard strokes but with problems in controlling trajectory, *placement*, or power. Thus, using the developmental shot at a high rate might result in irregular or random shuttle placement that made the opponents move. In addition, another immature stroke, the undifferentiated shot, was one performed with an awkward and odd form, which had a high chance as well of no regular shuttle placement, resulting in opponents' moving. Consequently, it might be reasonable to infer that the high rate of shuttle placement of two or three steps away from opponents observed in this study was largely due to the unintended performance resulting from students' inability to control shuttle placement.

The forceful stroke with the drive or smash appeared at very low rates across all the levels, with or without intent, although its use increased with enhanced skill levels. A similar result was reported in another study (Blomqvist, Luhtanen, & Laakso, 2000) that the expert young players intended more frequently to use forceful shots in the game, while the novice players chose to hit the shuttle over the net and keep the shuttle in play. Given that the participants in the study were all badminton beginners, it is reasonable to find them, as a whole, to use forceful strokes at limited rates. For implications, successfully and forcefully using the drive and smash may not be an appropriate instructional objective for all students in physical education classes, and could only be expected at a later stage of the badminton unit with limited occurrence or among limited students. As for the return to home base after stroking in return play, the finding indicates that it could be an area to be improved relatively quickly. Teachers could require students to perform it at the very beginning stage of the badminton game play, and use it as a criterion to measure or differentiate student progress.

The findings of the study may provide valuable information for assessing beginners' badminton performance. For instance, both developmental serve and developmental shot should be included in badminton assessment at the beginning of the learning stage. It appears that it would be more appropriate to use the developmental serve and developmental shot to measure beginning learners' performance in badminton, rather than using those standard serves and shots at an early learning stage.

In addition to the implications with specific findings of the study discussed above, the study also provides an opportunity for reflection on teaching sports skill in general. Researchers and practitioners seldom pay much attention to immature skills or tactics demonstrated among learners before they master standard ones, and how these immature skills or tactics change and lead to a transition to more mature skills or tactics. However, the data of the study suggest that students using immature forms of sports skill during initial learning stages could be a widely existing but ignored and uninvestigated phenomenon. Studying and understanding student immature forms of game play and their progress toward more mature forms may facilitate student sports skill acquisition. On the other hand, providing instructions based on expert performance or biomechanical analyses and requiring standard or mature movement patterns for beginning learners would result in poorer teaching effectiveness in many situations (Wulf & Weigelt, 1997).

Secondly, while sports skill acquisition is considered a key focus of physical education, there is a lack of consensus regarding to what extent student skillfulness should and/or could be reached (Ennis, 2011; Newell, 2011; Pangrazi, 2010). The findings of the study lead us to the following statement in this regard. Given limited allocated time for physical education classes, the genetic factor impacting sports skill acquisition, and the lack of valid and reliable sports skill tests, it could be difficult to expect all students to master skills of a sport taught in the physical education class alone (Pangrazi, 2010). On the other hand, based on the belief in the positive impact of sports skill on physical activity participation and from the perspective of educational physical education (Ennis, 2011), we advocate skill-oriented practice or physical activity in the physical education class plus supplementary after school skill-oriented physical activity programs through school-community partnerships. This might be an appropriate approach to contributing to increased physical activity participation, fitness development, and sports skill acquisition as well.

We realize that some limitations exist in this study. Due to the use of existing videotaped student badminton performance, the influence of the instructional process on student badminton performance is not known and was not taken into account in this study. For the same reason there is no information regarding the length of badminton units, which could impact the level of student performance in badminton game play as well. In addition, while the selected videotapes represented 20 students in each of the four skill levels, the skill distribution does not necessarily reflect the actual distribution of student skill levels in the badminton database of SCPEAP, or in the corresponding physical education classes at the end of badminton units. Furthermore, the changes found in this study in badminton game play across the developmental skill levels were observed using cross-sectional methods, and might not exactly match changes from longitudinal observations. Despite all these limitations, however, the study provides valuable and unique information in guiding badminton teaching in the physical education class. Further research addressing these limitations is desirable.

In conclusion, the study initially examined performance change in badminton game play across different developmental skill levels among high school students, contributing to the knowledge base in two ways. First, the conceptual model developed from systematic observations to analyze student performance in badminton game play is unique in including immature forms of serves and strokes in addition to standard ones. It turns out that identifying and analyzing immature serves and strokes can lead to a better understanding of student learning progress in badminton game play. The other contribution is the identification of the learning stages or performance changes of badminton game play across the developmental skill levels. We believe that the findings of this study will help physical education teachers make more informed instructional decisions when teaching badminton game play, and hope that the study will trigger more research in sports skill acquisition in physical education settings.

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