STUDIES IN SPORT, PHYSICAL EDUCATION AND HEALTH 77

Minna Blomqvist

Game Understanding and Game Performance in Badminton

Development and Validation of Assessment Instruments and Their Application to Games Teaching and Coaching

Esitetään Jyväskylän yliopiston liikunta- ja terveystieteiden tiedekunnan suostumuksella
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UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2001

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ABSTRACT

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Previous research in game settings in Finland has mainly focused on perfecting the technical aspects of game performance, whereas studying and developing game understanding as well as the teaching of games has gained far less attention. Therefore, the primary purpose of the present study was first to develop two valid assessment instruments to evaluate game understanding and game performance in badminton, and second, to apply the developed instruments to different age and experience levels. The third purpose was to set up an intervention study in order to study the effects of two types of instruction on game understanding and game performance of physical education students.

The participants in these studies were primary and secondary school children at different age levels (9, 12 and 14 years of age), junior badminton players (14 years of age) and physical education students in a teacher-training program. Multiple measures of knowledge, game understanding, skill and game performance were used to evaluate the various aspects of game performance.

The results of the first and second validation studies show that the instruments developed for the purposes of this project have shown themselves to be valid indicators of game performance. The third study, comparing experts and novices, clearly showed that skill, game play and cognitive components all differentiated experts from novices. The findings of the fourth study revealed that the strategy-oriented group, receiving skill instruction and video-based strategy instruction, was able to improve its badminton knowledge, game understanding and serving skill, whereas the traditional group, receiving only skill instruction, only improved its badminton serving skill.

In all, the findings of this study further confirmed the importance of cognitive abilities in game performance and suggest that the teaching of games should be reconsidered in order to produce both skillful and intelligent players.

Keywords: game understanding, game performance, badminton, assessment, validation, experience, intervention

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CONTENTS

LIST OF ORIGINAL PUBLICATIONS

The thesis is based on the following papers which will be referred to in the text by their Roman numerals I-IV:

I. Blomqvist, M., Luhtanen, P., & Laakso, L. 1998. Validation of a notational analysis system in badminton. Journal of Human Movement Studies 35, 137-150.

II. Blomqvist, M., Luhtanen, P., Laakso, L., & Keskinen, E. 2000. Validation of a video-based game understanding test procedure in badminton. Journal of Teaching in Physical Education 19, 325-337.

III. Blomqvist, M., Luhtanen, P., & Laakso, L. 2000. Expert-novice differences in game performance and game understanding of youth badminton players. European Journal of Physical Education 5, 208-219.

IV. Blomqvist, M., Luhtanen, P., & Laakso, L. The effects of a 6-week treatment period on badminton performance of P.E. students. Submitted.

In addition some unpublished results are presented.

1 INTRODUCTION

To play games without knowing "what to do and when" is difficult, if not impossible. Separate skills in different games can be learned and performed in isolation of the game, but in order to perform these skills in a game situation a player must use his/her cognitive skills to decide "what and when to perform". For this reason it could be argued that to be a successful games player requires more than just skillfulness, and therefore, the present investigation focuses mainly on these tactical aspects of game performance and pays less attention to aspects related to motor skill.

The practice of motor skills is crucial especially in low-strategy sports where executing the skill is the major determinant of success. In high-strategy sports, on the other hand, an athlete must also learn to adjust to the complex game situations in which response selection and decision-making must be learned (Thomas, 1994). Tactical awareness plays an essential role in game understanding. Bunker and Thorpe (1986) have indicated that the uniqueness of games is the decision-making process that precedes the execution aspect of performance in a game. They also contend that each game situation poses a problem and that this element of games lies within the cognitive area of learning.

Top-level badminton offers a good example of a high-strategy sport in which the highest levels of both cognitive and motor skills are required. During the game highly trained players are bound to solve hundreds of tactical situations appearing in a single match and in all the situations decisions must be made quickly and accurately. Nevertheless, badminton and its modified versions can also be considered suitable games for beginners. The racquets are light and easy to handle, the basic skills are quite easy to acquire and the main rules and basic tactical principles are simpler than for example in invasion games. Therefore, badminton seemed to be an appropriate game for studying game understanding and game performance at different age and experience levels.

In other countries physical education teachers have long been concerned with issues related to how to best teach sport and games to children. Many authors (e.g. Bunker & Thorpe, 1982, 1986; Griffin, Mitchell, & Oslin, 1997; Turner & Martinek, 1992) suggest that a greater emphasis in games teaching should be placed on teaching the tactical aspects of a game earlier to increase competence, interest and enjoyment in game play. Therefore, a model not previously used in Finland, called "Teaching Games for Understanding" (TGFU) (Bunker & Thorpe, 1982), has been introduced. This approach emphasizes the importance of the player making correct decisions in light of tactical awareness (Bailey & Almond, 1983). Similar ideas based on cognitivist and constructivist perspectives of teaching and learning decision-making skills (Grehaigne & Godbout, 1995; 1998b) are also presented. The main intention of these approaches (teaching for understanding) is to enable students to enjoy participation and to play the game reasonably well so that they will be more motivated to play and to gain the benefits of participation.

Both empirical studies and practical approaches to the training and teaching of games in Finland have focused especially on perfecting the technical aspects of movement production (how to do), and as a consequence the teaching of games in Finnish schools has mainly been technique oriented. Developing and studying decision-making skills (what to do/when to do) has gained far less if any attention, and therefore, this study opens up a new and important research area in the Department of Physical Education in the University of Jyväskylä. By applying the results and experiences of this study to the teacher training programs it would be possible in future to gradually transfer these new procedures, emphasizing the tactical aspects of game performance, into games teaching in the physical education settings at schools.

The primary purpose of the present study was first to develop two valid measurement instruments to assess game understanding and game performance in badminton, and second to apply these instruments to both beginning players and more advanced players of different ages to assess their game understanding and game performance in order to find out how the teaching of games should be improved to produce both skillful and thinking players. The third aim was to set up an intervention study based on the gathered information, concerning game understanding and game performance, in order to enhance both cognitive and motor skills of physical education students.

2 REVIEW OF THE LITERATURE

2.1 Nature of game performance

According to Thomas (1994), game performance can, for research purposes, be divided into *cognitive* and *skill* components. The cognitive component includes decision-making and knowledge, whereas the skill component includes motor execution (dribbling, shooting). Quality of decision-making in a game situation is often as important as execution of the motor skills, and both of these factors determine successful performance in sport. Another factor that influences game performance is *experience,* which usually increases linearly with age and is analogous to practice, performance and competition time. Both skill and knowledge should increase as a result of increased practice and competition (Thomas, 1994).

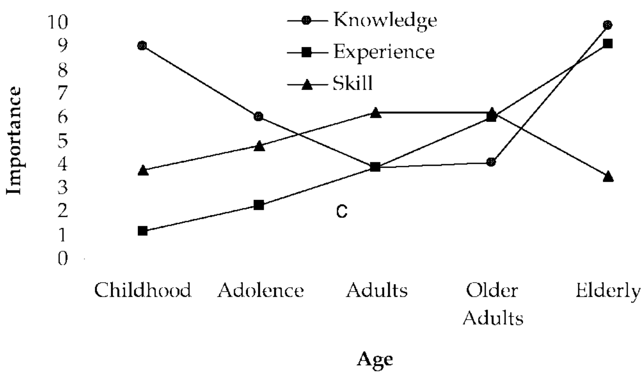

FIGURE 1 Hypothetical changes across age in the relative importance of knowledge, experience and skill for expert performers in high-strategy tasks (Abernethy, Thomas, & Thomas, 1993).

The combinations or interactions between these three components could also vary when producing expertise. The type of skill being performed, whether it is a high- or low-strategy motor task, and the age of the experts are the most influencing factors. The relative contribution of these components in high-strategy motor tasks is shown in Figure 1. According to this hypothetical model Abernethy et al. (1993) speculate that in young experts knowledge plays an essential role, whereas the role of experience is minimal and skill proficiency is moderate. In experts from late adolescence through the adult years skill and experience are likely to be the most important components, whereas knowledge plays a lesser role. In the elderly, on the other hand, knowledge and experience are the most important factors that enable the older experts to maintain high levels of performance.

It seems evident that motor expertise is a result of a complex interaction of many variables such as physical attributes, talent, knowledge, skill, intuition and motivation (Abernethy et al., 1993) and that expertise in sports develops over considerable time and practice. Studying the nature and development of expertise in sports differs considerably from many other areas of study. Firstly, in sport situations the decisions must be made quickly under heavy time constraints and secondly, knowing what to do and being able to do it are not necessarily related (Thomas & Thomas, 1994). The former situation means that if an athlete would have unlimited time, she/he would often make a better (or at least different) decision, and the latter situation implies that even though a subject shows expertise in a knowledge test, the same subject will not automatically demonstrate expertise in game play.

The following sections lay the foundation for this research by reviewing the theoretical bases and the research carried out in the areas of cognitive and motor skills and the development of expertise in sport.

2.1.1 Cognitive skills

The relationship between perception and action in sport-related tasks has mainly been investigated by using cognitive or ecological/dynamical approaches. According to present knowledge cognitive approaches seem more appropriate in skills involving a conscious formation of strategy (high-strategy motor tasks), whereas ecological approaches seem particularly suited to highly automated, repetitive motor skills (low-strategy motor tasks) (Abernethy et al., 1993; Williams, Davids, Burwitz, & Williams, 1992). The cognitive aspect of human skill has its origins in traditional cognitive psychology in which a typical assumption is that mind and body function in a way that is essentially machine like. The traditional information-processing models of motor skill performance serve as apparent expressions of this assumption. These models typically emphasize three sequential processes: 1) perception, through which a performer determines what is occurring, 2) decision-making by which an appropriate movement response is selected and 3) movement execution by which the selected response is organized, initiated and controlled (Abernethy, 1996; Abernethy, Kippers, Mackinnon, Neal & Hanharan, 1997).

Starkes and Deakin (1984) have discussed the information-processing capacities in terms of "hardware" and "software" attributes. Starkes (1987) examined several perceptual "hardware" abilities in field hockey players and found that elite hockey players did not differ in dynamic visual acuity, reaction time and coincident anticipation from moderate ability or novice players. On the other hand, differences were found in "software" abilities; skilled players had superior recall of game-structured information, made better use of advanced visual cues and made more accurate but not faster tactical decisions. Helsen and Pauwels (1993) investigated the relative importance of the "hardware" and "software" components of the visual system in soccer players and came to a similar conclusion that the most discriminating variables in determining expertise were the "software"-variables. Based on previous research (e.g. Abernethy, 1989; Abernethy, Neal, & Koning, 1994; Allard & Burnett, 1985; Garland & Barry, 1990, Starkes & Deakin, 1984; Starkes, 1987; Thiffault, 1974) it can be summarized that the hardware components underlying skilled performance, such as reaction time, dynamic visual acuity, and depth perception, have not been shown to adequately explain the level of expertise in sport, whereas the more cognitive software factors such as recall of game-structured information, signal detection, anticipation and complex decision-making have been shown to differentiate expertise.

Knowledge-based paradigm

Part of the research in the area of sport expertise has been conducted within the knowledge-based paradigm (e.g., French & Thomas, 1987; McPherson, 1993, 1994; McPherson & Thomas, 1989; Starkes, 1987; Thomas, 1994, Thomas, French & Humpries, 1986; Thomas & Thomas, 1994) developed by Anderson (1982; 1983). This Active Control of Thought (ACT*) -model was initially developed to examine expertise in more cognitive activities such as mathematics problems and writing computer programs. However, it has also been shown to serve as a theoretical framework for studying sports performance. The ACT* model shown in Figure 2 consists of three different memories: declarative, procedural and working memory. Declarative memory contains information concerning "what to do" and procedural memory contains domain-specific knowledge regarding "how to do something". Working memory contains the current information to which the system has access.

In Anderson´s theory, the performer has two links with the outside world; encoding processes deposit sensory information from the environment to the working memory and performance processes convert commands in the working memory into behavior or actions by the performer. Working memory is also linked to declarative memory by using the storage in which new permanent records are created and the strength of the existing records are increased and retrieval in which information is retrieved from declarative memory. The match process informs the production memory of the present conditions in the working memory and the execution processes transfer the appropriate production rules required for a behavioral response to the working memory. The application cycles which go back to the production memory box reflect the fact that new productions are learned by studying the outcome of existing productions, in other words, a performer learns by doing.

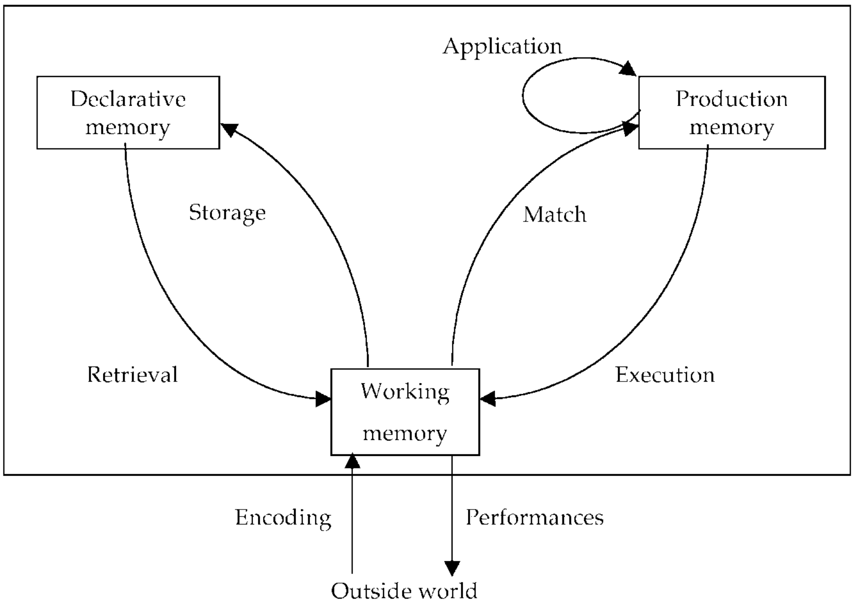

FIGURE 2 A general framework for the ACT production system (Anderson, 1983).

Knowledge compilation is a process through which declarative knowledge is transferred into procedural knowledge. This process enables errors in procedural information to be corrected over practice through two subprocesses: composition, which combines a sequence of productions into a single production, and proceduralization, which builds a version of the production that does not require declarative information to be retrieved from working memory. Generalization, discrimination and strengthening are the sub-processes of tuning by which the production set is made more appropriate and efficient for the task in hand.

Based on Anderson´s theory, sport knowledge can also be divided into declarative, procedural and strategic knowledge (e.g. French & Thomas, 1987; McPherson & Thomas, 1989; Thomas, Thomas & Gallagher, 1993). Declarative knowledge is factual information (facts, rules and definitions), procedural knowledge describes how to do something and strategic knowledge is information on how to learn or remember (Thomas, 1994; Thomas & Thomas, 1994). When children begin their sport participation they are usually novices and lack sport-specific declarative knowledge, which reduces the quality of the decisions they make within the context of the game. Many mistakes commonly observed in young children in various sports may stem from a lack of knowledge of what to do in a context of a given sport situation or from a lack of procedural sport knowledge (French & Thomas 1987). It has been suggested that declarative knowledge is necessary for the development of procedural knowledge (Thomas, 1994). This means that a participant must first have an adequate sport-specific declarative knowledge base before good decision-making skills can be developed within the context of the game (Thomas & Thomas, 1994).

There can be huge differences in knowledge and decision-making skills between novices and experts. Novices often lack declarative knowledge such as the goals and subgoals of the game, rules of the game, offensive and defensive strategies, terminology and etiquette, which are necessary for the development of more complex structures of procedural knowledge. The lack of procedural knowledge in novices is evidenced by their inability to select appropriate actions. Experts within a content area also seem to be able to solve problems more quickly and with fewer errors than novices, regardless of age (McPherson, 1993; 1994; 1999; McPherson & Thomas 1989; Thomas & Thomas 1994). A person who possesses a broad game-related knowledge base (e.g. stored information about rules, facts, past sensory information and outcomes of previous performances) has an advantage in decision-making in various sport situations when compared to a person without this kind of a knowledge base. Effective decision-making is important for the successful execution of skills, in other words, it is no use to master the basic shots in badminton if a player can not make a proper decision of when and where to execute a particular skill. When comparing experts and novices in game performance settings, French and Thomas (1987) found that child experts executed sport skills more effectively and made more accurate response selections (cognitive) during game play. Similar findings were also found in a study by McPherson and Thomas (1989), where the cognitive and sport skill execution components of performance discriminated expertise in youth tennis. On the other hand, when studying youth baseball players French, Spurgeon, and Nevett (1995) and French, Nevett, Spurgeon, Graham, Rink, and McPherson (1996c) found that skill execution components differentiated expertise levels but cognitive components did not. Nevett and French (1997) found that students were not able to produce sport-specific strategies with advanced quality until high school age.

2.1.2 Motor skills

According to Thomas et al. (1993) motor skills generally improve across childhood and adolescence, remain relatively stable during the early adult years and gradually decline with aging. Motor skill has been said to improve with age, due to increases in body size and strength, improved neuromuscular function, greater understanding of the goals and principles of movement and extensive practice (Thomas & Thomas, 1994). Furthermore, expertise can sometimes override the normal developmental processes, as found by French and Thomas (1987), and thereby younger children within their area of expertise can perform considerably better than older children who are novices in this particular sport (Thomas et al., 1993).

The most notable thing that happens when people practice is that they demonstrate increased proficiency in the task. Sometimes this change is obvious and in other cases special methods for observation and measurement are needed to detect these subtle changes (Schmidt & Lee, 1999). The acquisition of motor skills can be discussed in terms of three phases of practice: cognitive stage, associative stage and autonomous stage (Fitts, 1964; Fitts & Posner, 1967). These stages correspond with the stages introduced by Anderson (1982) in acquiring cognitive skills: declarative stage, knowledge compilation and procedural stage. The goal of learning is to gradually automate the skill through these stages. In the cognitive stage thought processes are heavily involved and the learner has to concentrate on performing the skill. The learner uses information on how the skill is to be performed, in other words the emphasis is on discovering what to do. When the focus is on perfecting the movement patterns and the learner starts to concentrate on the dynamics of the skill (timing, coordination) in order to produce smooth and refined actions, the learner is in the associative stage. In the autonomous phase the learner does not have to concentrate on the skill and performs without having to "pay attention" to the movement itself. At this stage performance is consistent and can be adapted to the requirements of the environment (Rink, 1998). Thomas et al. (1993) give an example of the three stages of learning for game play. At the cognitive level a player is concerned with keeping the ball in play (playing a cooperative game) by using a limited shot selection. Thereafter, the skills gradually develop and the player at the associative level is more consistent due to the integration and combination of skills that the player focuses on, directing the ball inside the boundary lines and avoiding errors. At the autonomous level the player is trying to force errors instead of focusing on avoiding errors. This is made possible by concentrating on detecting weaknesses of the opponent and by consistently using shots with which the opponent has difficulty. In addition, at this stage players are capable of anticipating opponents' actions as well as using deception in their own game.

Game playing, like many other performance-related tasks can best be understood in terms of issues related to what constitutes expertise and how it is developed. Therefore, research in sport expertise has identified a number of motor processes that characterize elite performers. Some of these player characteristics are higher scores on skill tests, higher success rates for skill execution during game play, performance in a less effortful and more automatic fashion, greater consistency and adaptability in movement patterns, superior self-monitoring, error detection and correction of skill execution (Rink, French, & Tjeerdsma, 1996b). Some similar features of expert performers were also found by McPherson and Thomas (1989) in comparing expert and novice tennis players and by French et al. (1995) in studying youth baseball players.

2.1.3 Expertise research

Since 1970, expertise has been studied across various domains (Chase & Simon, 1973; Chi, Glaser & Farr, 1988; Ericsson, 1996) and during the last two decades also in a wide range of motor tasks (Abernethy et al., 1993; Allard & Starkes, 1980; French & Thomas, 1987; McPherson & Thomas, 1989; Starkes, 1987). As a consequence an extensive, descriptive database is available on motor expertise. It has, among other things, been demonstrated that motor expertise is both task and context specific and that it does not consequently occur when generalized measures are used (Abernethy, 1996). In addition, motor experts are known to differ from novices in their domain of expertise in the following characteristics: more accurate pattern recognition, superior knowledge of both factual and procedural matters, knowledge organized in a deeper, more structured form, superior knowledge of situational probabilities, better able to plan their own actions in advance, superior anticipation skills, superior in sensing essential kinematic information, less effortful and more automatic performance, more consistent movement patterns, greater adaptability and superior self-monitoring skills

In a typical motor expertise research, two groups (expert and novice) are exposed to a single experimental task using methods derived from the cognitive psychology literature and the results give a description of expert-novice differences in this particular parameter. Abernethy et al. (1993) have criticized a number of aspects in this type of an approach to study motor expertise. The first concern relates to using knowledge-based approaches to study some aspects of motor expertise even though their value as being a powerful paradigm for studying the strategic elements of response selection have been recognized. Secondly, the available evidence indicates that expertise in sport is both task and context specific and does not emerge when generalized measures are used. The third concern relates to defining who is an expert - subjects can be classified as experts by one researcher and as intermediate by another researcher. A problem also arises if a group of true experts constitute a very small section of the population, and thus, there is always some trade-off between group size and the minimal criterion used to qualify as an expert (Abernethy et al., 1993; Abernethy, Burgess-Limerick, & Parks, 1994).

2.2 Determinants of game performance in badminton

Even though there are specific skills in each game, many similarities can be found in the tactical problems of different games. Almond (1986) introduced a classification system, which divides games to four categories according to their rules and tactical similarities: invasion, net/wall, fielding/run scoring and target games. Understanding certain constructs, such as time and space, is pertinent to many games and may facilitate the understanding of tactical principles for example in different net games (Jones & Farrow, 1999; Mitchell & Oslin, 1999). On the other hand, there have not been any attempts to study whether generic game understanding in one game form transfers to another game form (Rink et al., 1996b).

Typical features of net/wall games include players trying to send the ball into the court on the other side of the net in such a way that it is either difficult to return effectively, or it cannot be returned at all. According to Werner (1989), the basic strategy in net/wall games includes both fundamental offensive and defensive tactics. Making the opponent move long/short and side-to-side, attacking the net to get angle and trying to find opponent weaknesses are offensive tactics. Returning to home base, hitting clears to buy time and bisecting angle for best position are defensive tactics. According to Griffin et al. (1997) the corresponding skills needed for setting up an attack are the overhead clear and drop shot, which enable the basic form of the badminton game to take shape. Gradually, when the tactical complexity of the game increases, other types of shots such as serve (high and low), underarm clear, smash, smash return, and attacking drop shot are also needed in order to apply more complex tactics.

Decisions concerning appropriate actions in game situations are often as important as the execution of the motor skills to carry out those actions (French & Thomas, 1987). Game understanding, critical to game performance, can be defined as a player´s ability to solve tactical problems by selecting appropriate solutions in different situations and by selecting arguments for these solutions. The appropriateness of the actions taken by a player in a variety of situations represents the player's game understanding in that sport. However, the assessment of these actions is not an exact measure of game understanding. These actions may be influenced by both the game understanding of the decision-maker and by his/her ability to execute a desired sport skill. Therefore, measuring game understanding by assessing the actions taken by players in response to various game situations is clouded by whether or not the players are able to correctly execute what they decide to do in response to the game situation that confronts them.

Badminton is a game in which hundreds of tactical situations appear in a single match and in all the situations decisions must be made quickly and accurately. In badminton the alternatives in decision-making situations are directly dependent on the opponent´s strokes, and the time pressure is also a factor, thus limiting the useable alternatives in decision-making situations. Therefore, it is possible to some extent to anticipate the opponent´s next stroke based on the previous one (Östhassel & Sologub, 1987). The solutions to be carried out in decision-making situations in badminton are usually based on the placement of the shuttle; the height, speed and direction of the implement; the opponent´s position on the court and the striker´s own position in relation to the shuttle. In every stroke the player has to decide where to hit the shuttle and then return to home base, from where the player should have as fast and short a way as possible to the opponent´s next stroke. Tactical ideas must be practiced both in theory and practice and the player must always understand why the specific decision was made in the specific situation; otherwise the player won´t be able to make the decision in a game situation (Östhassel & Sologub, 1987).

2.3 Tactical approaches in games teaching

During the last two decades there has been a growing interest towards examining the approaches that physical educators use in their teaching. Many questions have arisen especially regarding the way in which games are taught. The "traditional" approach to teaching games has leaned heavily on the assumption that skills must be developed before the game can be played. The overall aim of this approach has been to produce skillful players (McMorris, 1998) and it has been characterized by direct instruction and a lesson format divided into an introductory activity, a skill phase focusing on developing and improving skill techniques, and a game. This approach has mainly produced children who achieve little success due to the emphasis on performance, school leavers who "know" very little about games, teacher-/coach-dependent performers, a dearth of "thinking" spectators and "knowing" administrators, and most importantly, skillful players who are not always able to use their skills in the game due to their inflexible techniques and poor decision-making capacity (Bunker & Thorpe, 1982). Bunker and Thorpe (1982) have speculated that the reason why teachers are so technique oriented lies partly in the teacher-training program in which skill acquisition and the measurement and evaluation of isolated techniques were set to be the main emphasis of games teaching.

Therefore, a growing interest has been shown towards an alternative approach introduced by Bunker and Thorpe (1982), "teaching games for understanding", which has gained the reputation of being a completely revolutionary innovation in the games curriculum. In this chapter the model will first be introduced, followed by other teaching styles suitable for this type of an approach.

2.3.1 "Teaching games for understanding"

Bunker and Thorpe (1982) proposed a model that fosters both tactical awareness and skill instruction. The model focuses on a "teaching for understanding" -approach, which does not assume that tactical awareness in games must wait for the development of sophisticated skills. On the contrary, this approach starts with a game, which is modified to ensure that all children can play and gain insight into the particular game, and suggests that teaching games should take place in six stages as shown in Figure 3. In the first stage of the model the age and experience of the learner are taken into account and a game form with adapted playing surface, number of players and equipment is introduced. This allows the players to practice the problems inherent in a game at their level of understanding and ability. The second stage emphasizes understanding the rules of the game. The rules give the game its shape and by altering the rules, the time and space constraints as well as the repertory of required skills and tactics are determined. During the third stage the basic tactical approach is formed based on the principles of play common to all games. This includes ways of creating space when attacking and of denying space when defending to overcome the opposition. In the fourth stage the difference between the decisions based on what to do and how to do are emphasized. Tactical awareness is necessary for making decisions because the situations and circumstances are continually changing. In order to decide "what to do", each situation has to be assessed and an appropriate response concerning "how to do" must be selected. The fifth stage describes the actual production of the required movement in terms of efficiency of technique and appropriateness of response. The teacher evaluates the movement, taking into account the context and the learner's limitations. The sixth stage is the observed outcome of the previous process, which is evaluated against criteria independent of the learner. After successfully completing these stages a reappraisal of the requirements of the new game must be carried out, and thereby, the cycle begins again (Bunker & Thorpe, 1982).

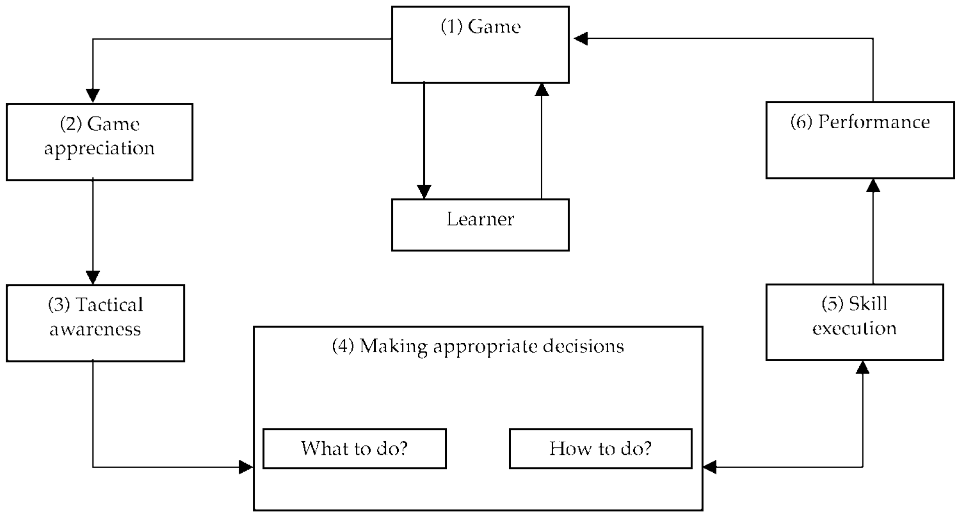

FIGURE 3 The TGFU model presented by Bunker & Thorpe (1982).

2.3.2 Constructivist perspective

One of the most important aspects in the debate of learning games concerns the underlying learning concept associated with the tactical approach. The issue of teaching generic tactics has been discussed widely (Grehaigne & Godbout, 1995; 1998b; Rink, French & Graham, 1996a; Rink et al., 1996b), based on Bunker and Thorpe´s (1982) recommendation that generic tactics should be taught indirectly. Grehaigne, Godbout and Bouthier (1999) have summarized the possible choices in using indirect and/or direct teaching strategies in light of a constructivist versus cognitivist perspective of the teaching-learning process as follows:

1. To propose to students the reproduction of the tactical skill that applies in a specific situation can be referred to as the direct teaching approach.
2. To propose to students the discovery of the tactical skill that applies in a specific situation can be referred to as the indirect teaching (empiricist constructivist) approach.
3. To propose to students the construction of suitable personal tactical skills that apply in a specific situation can also be referred to as the indirect teaching (radical constructivist) approach.

Based on Good´s (1996) definition "teaching for student understanding" is connected to the constructivist view of the teaching-learning process, and thereby, when applying the teaching for understanding approach, the two main teaching strategies to be identified are choices 2 and 3.

Grehaigne and Godbout (1998b) suggest that observation, critical thinking and transformation are the three key elements to be considered in a constructivist perspective of the teaching-learning process in team sports. Observation represents a critical moment in the teaching-learning process because in order to perceive decoding, classifying perceptions and organizing information is necessary. Critical thinking, central to a constructivist view of learning (Good, 1996), can be defined in many ways, as pointed out in several papers discussing the development and/or the use of critical thinking in physical education (e.g. Blitzer, 1995; Cleland & Pearse, 1995; McBride, 1991; 1995; Schwager & Labate, 1993; Tishman & Perkins, 1995; Woods & Book, 1995). According to Schwager and Labate (1993), critical thinking is seen as a useful tool that can help physical education teachers to achieve their goals. Grehaigne and Godbout (1998b) have introduced four strategies to be used in applying critical thinking in the teaching-learning process in team sports: 1) letting students explore, 2) asking open-ended questions, 3) taking part in students´ debate and asking specific questions, and 4) having students reutilize suitable solutions. A prerequisite in using these strategies is the use of verbalization, which can improve the students' learning of information, modeled actions and strategies as well as their self-efficacy in performing a task. Another effective tool when applying critical thinking is writing, which seems to be suitable for tasks where the aim is to foster understanding, change students´ conceptions and develop their thinking skills (Tierney, O´Flahavan, & McGinley, 1989; Schumacher & Gradwohl Nash, 1991). When students have transformed their initial behavior and have identified and verbalized the action rules that made their success possible, they can be considered to have truly learned (Grehaigne & Godbout, 1998b).

2.3.3 Pedagogical research

Recently, the advantages and difficulties of the tactical approach to teaching games and sports have been widely discussed in the physical education journals (e.g. Berkowitz, 1996; Chandler, 1996; Griffin, 1996; Rauschenbach, 1996; Turner, 1996; Werner, Thorpe, & Bunker, 1996). In addition, comparisons of the tactical and traditional approaches to teaching physical education have been the focus of many studies in recent years (e.g. Gabriele & Maxwell, 1995; Griffin, Oslin, & Mitchell, 1995; McPherson & French, 1991; Turner, 1996; Turner & Martinek, 1992; Turner & Martinek, 1995; Turner & Martinek, 1999), however, the results of these experiments have been inconsistent. Turner and Martinek (1992), studying 6^{th} and 7^{th} grade students playing field hockey, found no significant differences in declarative and procedural knowledge in classes that were taught using the "games for understanding" or "traditional" approaches. On the contrary, Turner (1996) in field hockey and Griffin et al. (1995) in volleyball found declarative knowledge to be significantly higher in tactical groups when compared to traditional and control groups. None of these studies (Griffin et al., 1995; Turner, 1996; Turner & Martinek, 1992) found any significant differences between tactical and technique groups in terms of skill performance in specific tests or in game execution.

According to Rink et al. (1996a), it is unlikely that a single teaching strategy will be applicable across sports and age levels, and therefore, it seems evident that the sport and the age level of the students will influence the findings of studies comparing teaching approaches. Another factor affecting research on teaching games and sports is related to the length and nature of the intervention. Several studies carried out in physical education were unable to demonstrate any significant differences or changes from pre- to posttest in selected variables, and it might be that in many of these studies the treatment period was not long enough for any learning to occur (Rink et al., 1996a). Studies by French, Werner, Rink, Taylor, and Hussey (1996a) and French, Werner, Taylor, Hussey, and Jones (1996b) suggest that 6 weeks of instruction provides a sufficient length of time, allowing for improvements in skills and tactics to take place. The last factor, introduced by Rink et al. (1996a) and influencing this type of research, is related to the variables chosen for investigation and how these variables are measured. Even though Thomas and Thomas (1994) suggest that multiple measures of skill, knowledge and game performance should be used in sport research because of the complex nature of sport performance, Rink et al. (1996a) remind that regardless of the measure that we use, it can only give information on one level/aspect of that domain. Therefore, the definitions of the variables used in research and the descriptions of the measurement techniques are critical to interpreting the results of a study (Rink et al., 1996a).

2.4 Assessment of game performance

When the aim of games teaching and coaching is to improve participants´ game performance, measurement procedures and instruments that can adequately assess all aspects of game performance are needed. Veal (1988) has introduced three different forms of assessment - preassessment, formative assessment, and summative assessment - depending on when assessment occurs and why it is implemented. In this chapter some earlier research and literature related to the assessment of decision-making (response selection) and game performance (response execution) are introduced and some limitations and concerns in the area of test development are presented.

Thomas and Thomas (1994) have suggested that multiple measures of skill, knowledge and game performance should be used in sport performance research. All these aspects of game performance have been taken into consideration by McPherson (1994) when introducing the measurement techniques related to tactical knowledge development and expertise in sports. One dimension in this continuum is response selection and response execution and the other is to know "what to do" (declarative knowledge) and "doing it" (procedural knowledge). Both dimensions are important areas of study, as are the complex relationships between these concepts.

Another model taking into account the various aspects of game performance has been introduced by Godbout (1990). This model (Figure 4) presents four objects of measurement in the area of physical education and sport. An observer may wish to consider the technical or tactical aspects of a player´s performance, or on the other hand, the assessment may be focused on the end result of the player´s actions (the product) or on how those actions are performed (the process). The combination of these two dimensions leads to the identification of four facets of performance: technical product, technical process, tactical product and tactical process.

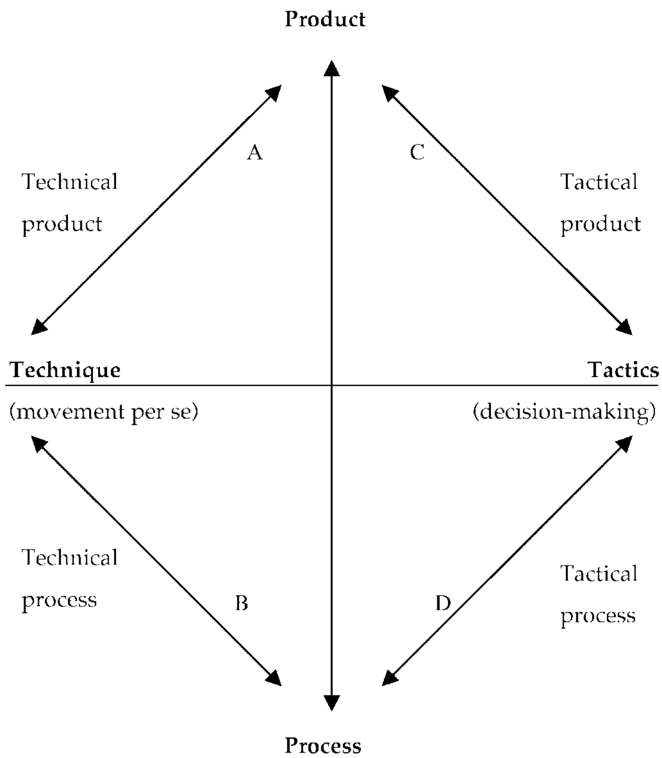

FIGURE 4 Facets involved in the measurement of motor skills (Godbout, 1990).

Regarding these facets of performance, various measurement strategies have been developed to collect information concerning the different aspects of performance. Godbout (1990) has also presented a two-dimensional model shown in Figure 5 to summarize these strategies. According to this model measures can be performed either in standardized setups or in real-life situations. On the other hand, the measurement procedure may be quantitative or qualitative in nature. When combining both dimensions, four general strategies for collecting information can be identified: standardized tests, statistics derived from competition, rating of performance in standardized setups and rating of performance during a game.

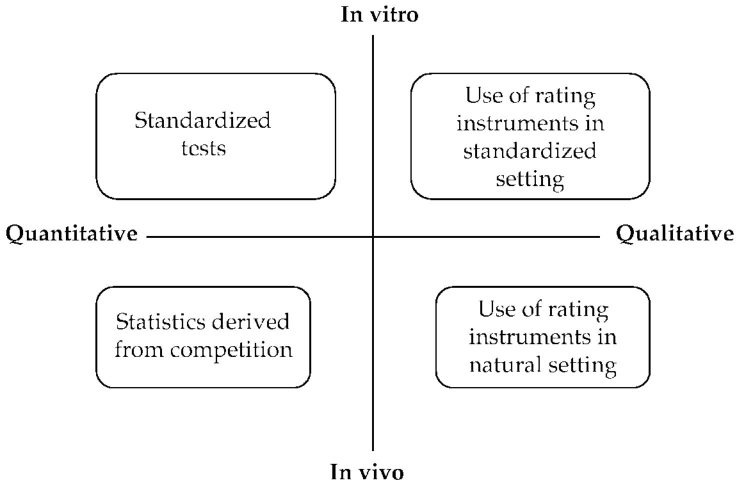

FIGURE 5 Measurement strategies with respect to motor skills (Godbout, 1990).

2.4.1 Decision-making

The main reason for the limited amount of research concerning decision-making in games has been the problem of objectively testing decision-making performance. Bard and Fleury (1976) made the first attempt to objectively measure decision-making by presenting slides of offensive game situations in basketball, however, reliability and validity of the test was not reported. Thiffault (1980), on the other hand, was the first to establish validity and reliability of his decision-making test in ice hockey. Slides of typical offensive ice hockey situations were presented to participants (three options), who were instructed to answer as accurately and quickly as possible. Speed of decision was used as a dependent variable, and the test-retest method and concurrent validity were used to establish reliability and validity of the test. Concurrently, Pauwels (1980) developed a similar type of test for soccer, in which reliability was not determined. Neither of these tests used expert coaches to examine the slides to verify face validity. On the contrary, other researchers (e.g. Marriot, Reilly & Miles, 1993; McMorris & MacGillivary, 1988; Starkes, 1987; Tenenbaum, Yuval, Elbaz, Bar-Eli & Weinberg, 1993; Yaaron, Tenenbaum, Zakay & Bar-Eli, 1997) developing similar decision-making tests for different team sports used experienced coaches to determine the validity of their tests. Helsen and Pauwels (1988) were among the first to develop a decision-making test in which the situations were presented on film. They argued that ecological validity in the film-based situations shown on a large screen would be better when compared to static slides. Video-based situations were also used by Yaaron et al. (1997) in examining the cognitive abilities of their participants in offensive, defensive and transition settings in basketball.

In addition to slides and video presentations some other methods, such as observation of performance (French & Thomas, 1987; McPherson & Thomas, 1989), questionnaires and interviews (French & Thomas, 1987) and verbalization of decisions (Nevett & French, 1997), have been used to study decision-making abilities especially in children. In all, the previous literature implies that different types of methods have been used in order to assess the decision-making ability of children and adults, mainly in different team games. Nevertheless, it seems obvious that reliability has not always been tested and validity has not been verified in all cases.

2.4.2 Game performance

Since skill and technical approaches have traditionally been used in teaching sports, the assessment of skill for summative purposes has been the primary instrument for student assessment in the means of response execution. According to Veal (1993, p. 95), "performance tests often test students on something that is completely unrelated to successful game play". Thus, the main disadvantage of a skill test score is that it does not demonstrate the ability of the student to perform skills when and where appropriate. Thomas and Thomas (1994) have proposed that the most content-valid way of measuring skills is through game play, in which game performance can be judged by the end result or by coding behaviors exhibited during game play. These types of measures are more authentic and represent a student´s ability more accurately.

Therefore, growing interest also in physical education settings has recently been shown towards developing assessment instruments that could address the process aspect of game performance. More authentic measurement instruments for formative assessment in team sports have been introduced. The Game Performance Assessment Instrument (GPAI) was created by Mitchell, Griffin and Oslin (1994) and it was "designed to provide teachers and researchers with a means of observing and coding performance behaviors that demonstrate the ability to solve tactical problems in games by making decisions, moving appropriately, and executing skills" (Mitchell, Oslin, & Griffin, 1995, p. 40). Grehaigne, Godbout, and Bouthier, (1997) created the Team Sport Assessment Procedure (TSAP) in which the basic idea was to take into account the players´ specific behaviors during offensive game play in order to provide teachers with reliable data on students´ game performance. A major characteristic of this assessment procedure is that it was developed for peer assessment purposes (Richard, Godbout, Tousignant, & Grehaigne, 1999). Both instruments were validated (Oslin, Mitchell, & Griffin, 1998; Richard, Godbout, & Grehaigne, 1998; 2000) and were found to be valid and reliable methods for assessing game performance.

The importance of feedback in the coaching process is also well recognized and the most accurate means for offering feedback of game performance is through the use of a specific notational analysis system. Although not widely used among teachers, many procedures have been developed for coaching and research purposes to analyze different games by using specific notational analysis systems, from simple hand notation to more complex systems using computers (e.g. Brown and Hughes, 1995; Eom and Schutz, 1995; Hong, Robinson, Chan, Clark, & Choi, 1996; Hughes, 1986; Hughes & Clarke, 1995; Hughes & Franks, 1994; Hughes, Franks, & Nagelkerke, 1989; Liddle and O´Donoghue, 1997; Liddle, Murphy, & Bleakley, 1996 Sanderson, 1983; Sanderson and Way, 1977). According to Hughes (1998), several areas of application for notation can be identified: tactical evaluation, technical evaluation, analysis of movement, development of database and modeling and educational use are examples of applying notation for teaching, coaching and research purposes.

3 FRAMEWORK AND AIMS OF THE STUDY

3.1 Framework of the study

A sport-specific research model (Thomas et al., 1986) has been used as a basis when constructing the framework for this study (Figure 6).

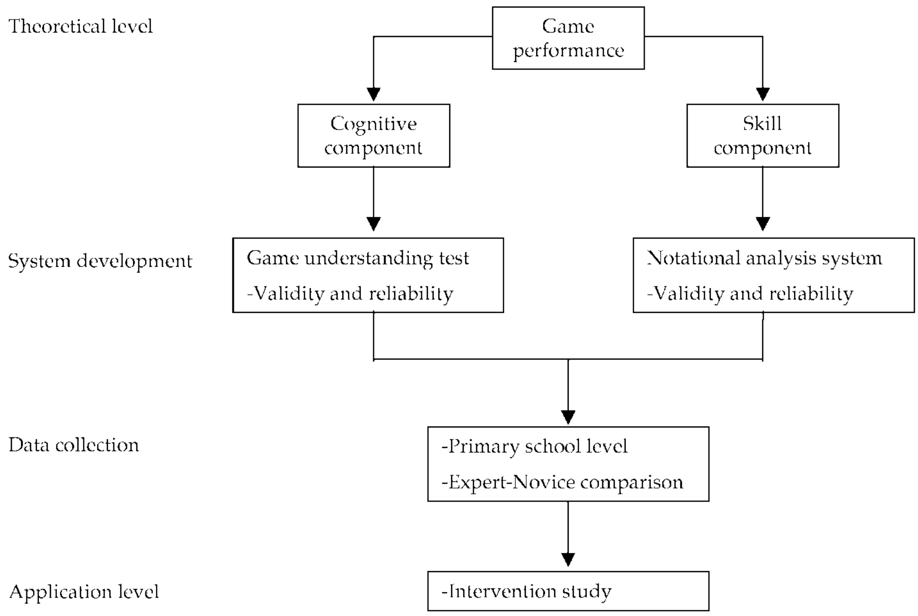

FIGURE 6 The framework of this study.

According to Thomas et al. (1986), "sport performance is a complex product of cognitive knowledge about the current situation and past events combined with a player´s ability to produce the sport skill(s) required". Thus, the emphasis of sport-specific research has been placed on the evaluation of both cognitive and motor skill components of game performance to find out how the teaching and coaching of games should be developed to produce both skillful and thinking players.

The general purpose of the present series of studies was first to develop valid and reliable instruments to assess game understanding and game performance in badminton, and second, to examine age-related differences in game understanding and game performance at novice level. Furthermore, an expert-novice comparison was made to trace the essential attributes distinguishing experts from novices. Finally, this comparison was used as a basis for determining what traits are to be emphasized when enhancing the development of expertise in badminton game performance.

3.2 Aims of the study

The primary aims for this study stem from the following research questions:

1. Can game understanding and game performance be validly measured?
2. Are there age group differences in game understanding and game performance at primary school level?
3. How do experts and novices differ in badminton game understanding, specific skills and game performance, and is there a relationship between the measured variables?
4. How do two forms of instruction effect the P.E. students´ game understanding and game performance?

In order to answer these questions, an appropriate game understanding test procedure and an analysis system for assessing game performance in badminton were developed. In addition, reliable and valid badminton skill and knowledge tests were selected and a variety of other questionnaires for students, players, teachers and coaches were developed.

More specifically, the aims of the series of four different studies were:

1. To develop a valid and reliable analysis system to evaluate game performance.
2. To develop a valid and reliable test to assess game understanding.
3. To compare experts and novices in game understanding and game performance.
4. To study the effects of a 6-week treatment period on badminton performance of P.E. students.

4 METHODS

The whole research project has been divided into three separate phases (Figure 7). PHASE 1 contains the development and validation of the notational analysis system (1a) and the game understanding test procedure (1b) for badminton. In PHASE 2 the developed instruments were applied at first to a primary school level (2a) and then to expert and novice levels (2b). PHASE 3 contains the intervention study designed for physical education students. The general design of the research project as a whole and the measurement instruments used in the different studies (I, II, III and IV) will be presented in the following sections.

4.1 Total study design

The planning of this research project started in 1995 and the project continued until 1999. The notational analysis system and the first version of the basic game understanding test were ready to be tested at the beginning of 1996 and the first pilot studies were carried out at the Kortepohja primary school in Jyväskylä, Finland. Soon after this the actual data collection started by applying the developed test procedures to 9-12-year-old primary school children (n=120).

In 1997 the notational analysis system was validated and an advanced game understanding test was developed and applied to both novice (n= 45) and expert (n=19) players to further validate the test procedure. All participants played singles badminton and participated in skill and advanced game understanding video tests. In addition, expert (n=12) and novice (n=14) comparison was made with a sample of the previous expert and novice groups.

In 1998 an intervention study was designed in order to enhance game performance of physical education students (n=30). Students were divided into two treatment groups and a control group and received badminton instruction for a 6-week period. Pre- and posttest measures were made to detect differences between the groups and to trace the development in badminton knowledge, game understanding, skill and game performance.

PHASE 1 (I, II)

a) Development and validation of a notational analysis system (n=413)

b) Development and validation of a basic (n=120) and advanced (n=64) game understanding test

PHASE 2 (II, III)

a) Game understanding and game performance at primary school level (n=20)
- basic game understanding test
- game performance in badminton and a throwing-catching game
-

b) Expert-novice comparison (n=26)
- advanced game understanding test
- skill test in badminton
- game performance in badminton

PHASE 3 (IV)

Intervention study with physical education students (n=30)
- knowledge test in badminton
- advanced game understanding test
- skill test in badminton
- game performance in badminton

FIGURE 7 Schematic overview of the total study design.

4.2 Notational analysis system (I, III, IV)

The schematic layout of the match analysis system used to analyze all the matches in this study is shown in Figure 8. Matches were recorded with a video camera (25 frames/s) located behind and above the court and analyzed afterwards by utilizing the playback, slow motion, still frame, and accurate time counter functions of a video cassette recorder, a TV, and a computer including Sage™ Game Manager for Badminton software.

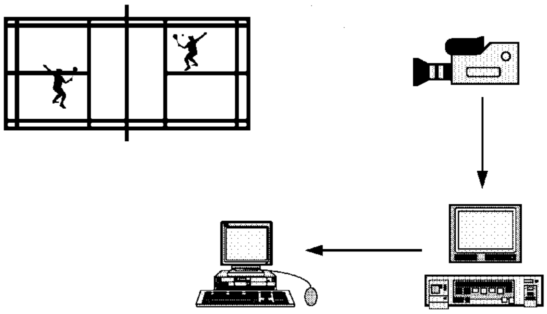

FIGURE 8 Schematic layout of the notational analysis system.

The software consisted of four parts: database, event entry, match analysis and player profile. With the help of the database application a tournament was created including the name, place, date and court dimensions of the tournament. The match details were entered including players' names, gender and category of play. In the event entry the events of the particular match were entered, based on the video material (Figure 9). To enter the events a computer mouse was used to open the pop-up menus in the event table (Figure 10) in order to code every shot. At the beginning and end of each rally the time was updated to within 1 second.

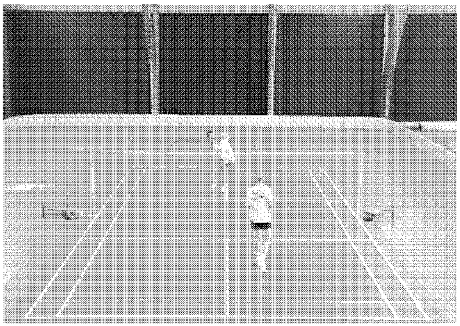

FIGURE 9 A game situation in a match.

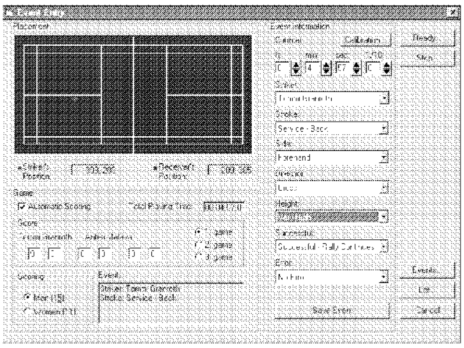

FIGURE 10 The event entry of the analysis system.

4.3 Game understanding test procedure (II, III, IV)

Development and Description of Basic Test

The basic video test used in this study included 19 different sequences, which were video simulations of actual offensive and defensive game situations. Two experts selected these sequences from a tape where two 12-year-old badminton juniors were playing. One expert was the researcher and the other a national-level badminton coach.

Each video sequence contained three stages: live video, still frame and a diagram. The live video began with a serve and was then played for 4-7 seconds. After the live video, a still frame (Figure 11) of the situation where the other player was getting ready to play his/her stroke was shown for 10 seconds. Finally, a diagram (Figure 12) from which the subject could choose his/her response from the arrows representing three stroke response options was shown for 10 seconds. The sequences were separated by 30 seconds of blank tape. During this time the participants had to select the appropriate option out of the three alternatives on a separate sheet of paper. The participants also had to choose two arguments from a set of ten arguments (Table 1) to give a reason for choosing to operate in a certain way.

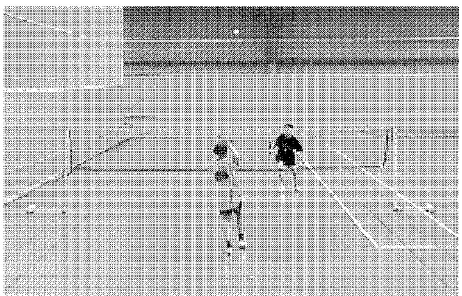

FIGURE 11 An example of a video sequence in the basic test.

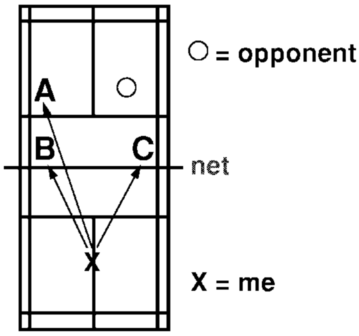

FIGURE 12 An example of a diagram in the basic test.

TABLE 1 A list of the arguments used in the basic test.

	Arguments
1.	in order to have as much time as possible to get to the next stroke
2.	because it is much harder to move backwards
3.	so that my opponent has to move as far as possible to his/her next stroke
4.	because my opponent was moving in the other direction
5.	so that my opponent has as little time as possible to get to the next stroke
6.	so that my opponent has to change direction
7.	because his/her racket was on the opposite side
8.	because it is harder for my opponent to hit from this side
9.	because this is my best stroke
10.	because my opponent would not expect this kind of a stroke

Development and Description of Advanced Test

The advanced test used in this study consisted of two progressive parts (A3 and A8), which both included 15 different sequences. The A3 test (Figure 13), containing three alternatives and arrows to describe the characteristics of the strokes, was to be easier than the A8 test (Figure 14) that gave more alternatives and did not describe the characteristics of the strokes. Six badminton experts, all of whom had many years of coaching and teaching experience, were used to select the 15 sequences out of 36 situations from a tape where two 18-year-old top badminton juniors were playing.

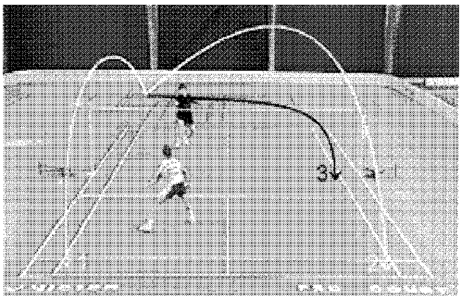

FIGURE 13 An example of a video sequence in the A3 test.

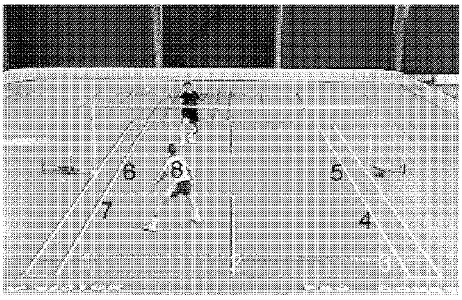

FIGURE 14 An example of a video sequence in the A8 test.

Each situation started with play for 2-7 seconds and was followed by a still frame for 10 seconds of the situation in which the opposing player was getting ready to play his/her stroke. The players had to decide what they would do in each situation based on a still frame representing three (A3) or eight (A8) alternatives of the player´s stroke responses. In addition, the participants had 60 seconds to choose as many relevant arguments as they could find (II) or two arguments (IV) from a set of twenty arguments, to verify their decision (Table 2). The sample responses for the video sequence examples, described in Figures 11, 12, 13 and 14 are shown in Table 3.

TABLE 2 A list of the arguments used in the advanced test.

	Arguments
1.	because my opponent is in an imbalanced position
2.	so that my opponent has to move as far as possible to his/her next stroke
3.	because it is difficult for my opponent to move in that direction
4.	so that my opponent has to change direction in the home base
5.	so that my opponent has to move backwards
6.	because the shuttle is high on the net
7.	because the shuttle is close to the net
8.	because the shuttle is far away from the net
9.	because the hitting player is late in the situation
10.	because the hitting player is on time in the situation
11.	because the stroke is solid
12.	because the stroke is safe
13.	because the stroke is surprising
14.	in order to have as much time as possible to get to the next stroke
15.	so that my opponent has as little time as possible to get to the next stroke
16.	because the hitting player is in a balanced position
17.	because it is the back hand side for my opponent
18.	because the hitting player has to strike the shuttle from near the baseline
19.	because my opponent´s stroke to the back court was too short
20.	because it is hard for my opponent to strike a difficult stroke from there

TABLE 3 The sample responses for the video sequences.

	Selected shot options			Selected arguments		
	1.	2.	3.	1.	2.	3.
Basic (B)	A	B	C	5, 4	3, 6	-
Advanced (A3)	2	3	1	2,3,10,20	6,10,12,15	-
Advanced (A8)	3	5	1	2,3,10,20	6,10,12,15	-

Grading Responses

The number of test items, stroke and argument alternatives and possible selections, corresponding points, and possible scores in the different tests are shown in Table 4. In both tests, a weighting scheme based on the experts´ judgments was used to score the participants' stroke and argument responses. Two points were awarded for the best stroke option, one point for the second best stroke option and no points for the third stroke option selected in each of the sequences. The set of 10 (B) and 20 (A) arguments provided for each sequence were divided into three groups. Two points were awarded for each selection of an argument in the best group, one point for each selection of an argument in the second best group, and no points were awarded for selections in the incorrect group. Each subject received three scores related to the observed video sequences in all tests: the sum of the points obtained from the selected stroke options (SSO) and selected argument options (SAO), and the total amount of points (TAP).

TABLE 4 The number of test items, stroke and argument alternatives and possible selections, corresponding points and possible scores in the different tests.

Test	Test Items (N)	Alternatives strokes/arg. (N)	Selections strokes/arg. (N)	Points strokes/arg.	Score strokes/arg. (max)	Score total (max)
Basic (B)	19	3/10	1/2	2, 1, 0	38/76	114
Advanced	15	3/20	1/1-4	2, 1, 0	30/120	150
Advanced	15	8/20	1/1-4	2, 1, 0	30/120	150

Note. arg. = arguments.

4.4 Skill test (III, IV)

The skill test used in this study (for serve, clear and drop) was modified from the test battery that the Finnish Badminton Association recommends when assessing badminton skills of competitive players (Sipiläinen, Danskanen & Heinonen, 1997). Two courts were prepared for skill testing and two assistants were used to serve the shuttle for the participants in testing the clear and the drop shot. Both assistants were trained to reliably hit the shuttle to the desired location with an appropriate trajectory. In every test, there were four scoring areas of which the smallest area gave 10 points, then 5, 3 and 1 point from the largest area. Each participant performed two practice trials and 10 test trials in every test shot.

Serve. The long-serve test was used to assess serve skill. The participants were asked to hit a high and long serve from the right service court towards the four scoring areas (radius 40, 80, 120 and 160 cm) near the center- and baselines (Figure 15, area I).

Clear. In testing the clear, the participants were told to stand in the right receiver´s box 1.5 meters from the baseline and hit a clear from the assistant´s serve (equivalent to player´s vertical reach) towards the four scoring areas near the side- and baselines (Figure 15, area II).

Drop. In testing the drop shot, the participants were told to stand in the right receiver´s box 1.5 meters from the baseline and hit a drop shot from the assistant´s serve (equivalent to player´s vertical reach) towards the three scoring areas (radius 1.5, 2.0, 2.5 m) near the net and the service line (Figure 15, area III).

Three variables were formed based on the results of the ten test trials in each shot, serve (SE), clear (CL), and drop (DR), and a total score in the skill test (ST) was calculated as the sum of all the points. The correlation coefficients between the repeated measures in 10 junior badminton players were .75 in clear and .94 in serve.

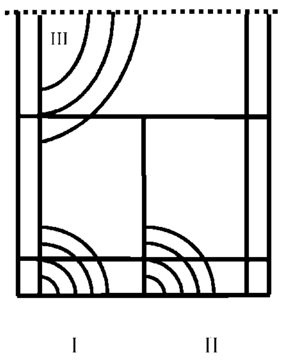

FIGURE 15 Target areas of the skill test for a right-handed player.

4.5 Knowledge test (IV)

The knowledge test used in this study was constructed based on McGee and Farrow´s (1987) book "Test questions for physical education activities." The knowledge test was composed of 36 items selected from the badminton test battery of this text: 4 terminology items, 18 items on rules and scoring, 11 items focusing on technique, and 3 items focusing on strategy. The knowledge test score (KT) for each participant was the total number of items answered correctly. Internal consistency of the knowledge test was examined by calculating the coefficient alpha for the 36 test items $\alpha = 0.70$.

5 RESULTS 1: Development of the instruments

The results of this study are presented in two separate sections. The first section consists of the results concerning the validation of the instruments (PHASE 1). Both instruments are presented separately due to differences in study designs.

5.1 Notational analysis system

5.1.1 Problem setting

Even though there are reports in the literature concerning the notational analysis systems in other sports, there seems to be a need for computerization of data collection and analysis in badminton (Liddle et al., 1996). The hardware (Figure 7) and software of the Sage™ Game Manager for Badminton used in this study have been developed to analyze the development of game performance and game understanding in badminton (Blomqvist, Luhtanen, & Laakso, 1997a; 1997b). In order to minimize problems in this kind of an analysis a careful validation of the system must be performed by determining the intra- and inter-observer reliability of the notational procedure. Therefore, the purpose of Study I was to determine the validity of the badminton notational analysis system.

5.1.2 Methods

Two of the best Finnish junior players in the age group under 15 years participated in this study. They played two full games of singles badminton with the duration of the match being 18 min. 25 s. The match was video recorded and analyzed afterwards by three trained observers who all coded the whole match twice (Table 5) according to written instructions. All the observers had played and coached net and wall games for many years: observer 1 in squash, observer 2 in volleyball and observer 3 in badminton.

After entering all the events in the computer according to the written definitions the match was analyzed with the match analysis program which gave frequency distributions, percentages and mean values of the output variables shown in Table 6. Three different variables were formed based on positional and temporal information: total distance travelled by the player (DT) calculated based on the start position (x, y) of the striker and his/her next position at the moment when the opponent was hitting the shuttle (receiver´s placement), total playing time (TT) which was the time calculated from the first serve to the end of the last rally, and effective playing time (ET) which was total time minus rest time between the rallies.

TABLE 5 Number of observations in the different categories of the variables.

	Category of variable			
Observer	1	2	3	k
ij = 11	n_{111}	N_{112}	n_{113}	n_{11k}
ij = 12	n_{121}	N_{122}	n_{123}	n_{12k}
ij = 21	n_{211}	N_{212}	n_{213}	n_{21k}
ij = 22	n_{221}	N_{222}	n_{223}	n_{22k}
ij = 31	n_{311}	N_{312}	n_{313}	n_{31k}
ij = 32	n_{321}	N_{322}	n_{323}	n_{32k}

TABLE 6 The input and output variables of the analysis system.

Input variables	Output variables
Time	Total playing time (TT)
	Effective playing time (ET)
Striker	Player A, B
Position of the striker	Average starting point and ending point of strokes (start X, start Y, end X, end Y)
	Average length of strokes (LS)
Position of the receiver	Placement of the receiver (RP)
	Total distance travelled (DT)
Stroke type	Number of strokes (TS)
	Distribution of strokes
Side	Side (forehand, backhand) (SI)
Direction	Direction (direct, cross) (DI)
Height	Height (very high, high, low) (HE)
Success	Success (rally continues, into the court, off the court, into the net) (SU)
Error	Error (no error, forced error, unforced error) (ER)
Shot execution	Execution (strong, weak) (SE)
Shot decision	Decision (strong, weak) (SD)

The frequency distributions of the data were calculated and a statistical analysis was performed using SPSS software. Three types of validity; logical, criterion and construct validity were examined and the intra- and inter-observer reliability of all variables was calculated as Pearson´s correlation coefficients.

5.1.3 Results

Validity

According to Thomas and Nelson (1996) logical or face validity is assured when the measure clearly involves the performance being measured. Therefore, it seems obvious that a notational analysis system is valid by definition. The criterion validity of this analysis system was examined in 19 junior badminton players by comparing the game analysis results and the player´s position in the national junior ranking of the Finnish Badminton Association. Significant negative correlations were found between effective playing time and the player´s ranking position ($r_s = -.60$, $p < .01$) as well as between forceful shots and the player´s ranking position ($r_s = -.63$, $p < .01$). In other words, the higher ranked players played longer rallies with more effective shots (Blomqvist, Luhtanen, & Laakso, 1999). As reported in study III, the analysis system was also able to differentiate between novice and expert players. The experts played longer shots, travelled a longer distance on court and used a variety of different shots as well as more forceful shots. These findings verify the construct validity of this analysis system by detecting differences in badminton game performance between players of high and low ability.

Reliability

The entire match included 413 shots and the frequencies of the different shots were as follows: serve (S) 69, clear (C) 86, drop (D) 72, net drop (ND) 57, drive (DR) 4, lob (L) 56, smash (SM) 39, and smash return (SR) 30. The percentages of the intra- and inter-observer agreement levels are shown in Tables 7 and 8. The highest intra-observer agreement was found in the following shots: serve, lob and smash return (100%) and the lowest in the drop shot (84.5%). The highest inter-observer agreement was found in the lob and the smash (100%) and the lowest in the drop shot (87%).

TABLE 7 The percentages of intra-observer agreement levels in the selected shots.

Observer	S (%)	C (%)	D (%)	ND (%)	L (%)	SM (%)	SR (%)
11 – 12	98.6	98.9	95.8	98.2	98.2	92.9	93.8
21 – 22	100	98.8	98.5	96.5	100	97.7	100
31 – 32	100	90.2	84.5	98.3	100	97.7	96.8

TABLE 8 The percentages of inter-observer agreement levels in the selected shots.

Observer	S (%)	C (%)	D (%)	ND (%)	L (%)	SM (%)	SR (%)
12 – 22	98.6	96.6	98.6	98.2	98.2	100	97.0
12 – 32	98.6	94.6	87.0	98.2	100	97.7	96.9

The intra- and inter-observer correlations of the length of the shots, receiver´s placement, distance travelled by the player, total playing time and effective playing time are shown in Tables 9 and 10. The highest intra- and inter-observer correlations were found in total playing time (r=.997 and r=.997, respectively) and the lowest in total distance travelled (r=.871 and .813, respectively).

TABLE 9 The intra-observer correlations in the selected variables.

Observer	LS	RP (x)	RP (y)	DT	TT	ET
11 – 12	.960	.900	.955	.883	.997	.990
21 – 22	.972	.938	.965	.922	.997	.991
31 – 32	.959	.876	.912	.871	.994	.982

$r \geq .871$, $p < .001$

TABLE 10 The inter-observer correlations in the selected variables.

Observer	LS	RP (x)	RP (y)	DT	TT	ET
12 – 22	.953	.883	.942	.883	.997	.988
12 – 32	.923	.857	.917	.813	.991	.986

$r \geq .813$, $p < .001$

The intra-observer reliability coefficients of the type and quality of shots can be seen in Table 11. The lowest correlation coefficient was found in the variable shot decision (r=.321) and the highest in the variable successful (r=1.000).

TABLE 11 The intra-observer correlations in the selected variables.

Observer	TS	SI	DI	HE	SU	ER	SE	SD
11 – 12	.966	.938	.932	.893	.984	.957	.742	.428
21 – 22	.993	.919	.937	.913	1.000	.989	.839	.321
31 – 32	.979	.960	.918	.827	1.000	.942	.807	.549

$r \geq .321$, $p < .001$

The inter-observer correlation coefficients can be seen in Table 12. The lowest correlation coefficient between the observers was found in the variable shot decision (r=.134). and the highest in the variable successful (r=1.000).

TABLE 12 The inter-observer correlations in the selected variables.

Observer	TS	SI	DI	HE	SU	ER	SE	SD
12 – 22	.951	.920	.942	.850	1.000	.989	.720	.266
12 – 32	.942	.968	.894	.818	1.000	.965	.661	.134

$r \geq .266$, $p < .001$; $r \geq .134$, $p < .01$

5.2 Game understanding test procedure

5.2.1 Problem setting

In attempting to measure a phenomenon for which there is no universally agreed measure, it is important that the test is checked formally for its reliability and validity. In other words, the basic principles of test development must be carefully followed when constructing a test. According to Safrit (1986), this means that a test should first be valid in that it measures what it was intended to measure. Secondly, it should be reliable (defined as the degree of consistency of the test). Three types of validity; content, construct and criterion validity (Coolican, 1994; Safrit & Wood, 1989; Thomas & Nelson, 1996), and three types of reliability; internal consistency, parallel-form and stability (Thomas & Nelson, 1996) are generally defined in the literature and were also examined in this study. Other factors affecting the size of reliability coefficients were the type of reliability coefficient, homogeneity or heterogeneity of the data and the size of the group. Test and tester characteristics were also considered. Thus, the purpose of this study was to develop and establish the validity and reliability of a badminton test procedure in order to be able to assess game understanding in badminton.

5.2.2 Setting and participants

In developing the test procedure a basic test (B) was first constructed to measure game understanding in children who were novices. Primary school children in two different age groups (9-10 years, n = 61 and 11-12 years, n = 59) served as participants in the basic test. The participants were divided into four groups and they performed the test in their own classrooms during the normal school hours on consecutive days. Prior to each test, all participants were given the same instructions on how to take the test and then familiarized with the test by rehearsing one situation together with the tester. The test began after the rehearsal.

Based on the experiences of the basic test, an advanced test (A) was constructed afterwards to measure game understanding in expert junior badminton players. The advanced test was applied to both expert (11-14 years, n = 19) and novice (11-14 years, n = 45) players. The experts were national-level junior badminton players and the novices were primary and secondary school children. The novices performed the game understanding test in their own classrooms during the normal school hours and the experts during their badminton practice hours in the evening. The advanced test consisted of two parts, A8 and A3, of which the A8 test was completed first, immediately followed by the A3 test. Prior to each test, all participants were given the same instructions on how to take the test and then familiarized with the test by rehearsing one situation together with the tester, after which the test began. The time interval between the test times was 2 to 4 days to establish reliability. In all the tests (B and A), the video sequences were shown on a large screen (1.2 x 1.2 meters) by a Sharp Vision XV-330H videoprojector.

5.2.3 Results

Content Validity

Content validity of a test is assured by demonstrating that the items in the test adequately represent all important areas of the content (Safrit, 1986). In this study, the content of the basic test was selected by two experts who judged the test to be a valid measure of the basic tactical principles in badminton. In the advanced test, six experts were used in different phases to construct the test by using Delphi techniques (Thomas & Nelson, 1996). Therefore, it could be argued that the selected test items were essential for the game, representing all important areas of the game which, according to Werner (1989), are in the offense; making the opponent move long/short and side to side and attacking the net to get angle, and in the defense; returning to home base, hitting clear to buy time and bisecting angle for best position.

Construct Validity

Construct validity is used with features that cannot be directly measured and it can sometimes be established by the known group difference method (Safrit, 1986; Thomas & Nelson, 1996). In this study, the basic test´s ability to differentiate between the selected age groups was examined by using an independent t-test, and the corresponding results are shown in Table 13. As can be seen, a significant difference was found between the age groups 9-10 and 11-12 years in SAO ($t[118] = 2.45$, $p < .05$) and TAP ($t[118] = 2.40$, $p < .05$). Both age groups were equally good in selecting the right stroke option, whereas the older age group was better in argumentation.

In the advanced test, the participants who were rated as novices had no previous experience in badminton and those that were rated as experts were national-level badminton juniors in the corresponding age group. The known group difference method was applied to study whether the test distinguished between these groups. An independent t-test was applied to detect differences between the novice and expert groups, and the results showed that there were significant differences between these groups in all the variables in the A3 and A8 tests (Table 13).

In both the basic and advanced test the differences between the groups were further investigated by calculating effect sizes to determine the meaningfulness of the group differences, using pooled standard deviations (Thomas & Nelson, 1996). As shown in Table 13, effect sizes (ES) ranged in the basic test from 0.29 to 0.45, in the A3 test from 0.87 to 1.67 and in the A8 test from 1.69 to 2.17. According to Thomas & Nelson (1996) all these effect sizes can be considered meaningful; in the basic test the differences were small to moderate and in the advanced test they were large ($ES > .80$). These findings clearly indicate that the tests were able to detect differences between the groups in each game understanding variable.

Criterion Validity

In assessing criterion validity, test scores can be compared with one or more external variables to ascertain the test´s validity (Safrit, 1986). According to Barrow, McGee, & Trischler (1989), in physical education and sport this alternative criterion could include such aspects as expert´s judgments of coaches, tournament results or competition scores. The criterion used in this

TABLE 13 Comparison of the scores in different video tests between the groups: A test of construct validity.

	Basic				Advanced (A3)				Advanced (A8)			
	9-10 (n = 59)	11-12 (n = 61)			Novice (n = 45)	Expert (n = 19)			Novice (n = 45)	Expert (n = 19)		
	M	M	t	ES	M	M	t	ES	M	M	t	ES
SSO	27.48	28.76	1.61	0.29	15.76	18.26	2.81**	0.87	8.82	15.68	7.93***	2.17
	(4.54)	(4.20)			(2.60)	(3.51)			(2.87)	(3.79)		
SAO	24.89	29.24	2.45*	0.45	4.37	24.04	4.42***	1.63	4.90	18.55	4.71***	1.69
	(9.48)	(9.99)			(7.77)	(18.75)			(5.64)	(12.09)		
TAP	52.36	58.0	2.40*	0.44	20.12	42.30	4.54***	1.67	13.72	34.24	6.12***	2.14
	(13.05)	(12.71)			(8.80)	(20.50)			(7.11)	(13.87)		

Note. Standard deviations are given in parentheses. SSO = selected shot option; SAO = selected argument option; TAP = total amount of points.
* $p < .05$. ** $p < .01$. *** $p < .001$.

study to assess the validity of the advanced test was player´s position in the national junior ranking of the Finnish Badminton Association. Significant negative correlations were found between the total amount of points and the player´s ranking position in the expert group (A3: $r_s = -.70$, $p < .01$ and A8: $r_s = -.61$, $p < .01$). In other words, the higher the ranking, the better the results in the game understanding test.

Reliability

Internal consistency is the degree to which people perform similarly throughout all parts of the test (Barrow et al., 1989), and it was obtained in this study by using the coefficient alpha technique. In the basic test, the coefficient alpha was calculated from the total amount of points in the nineteen situations ($\alpha = .73$). In the advanced test, the coefficient alpha was calculated from the total amount of points in the fifteen situations in the expert (A3: $\alpha = .81$ and A8: $\alpha = .72$) and novice (A3: $\alpha = .65$ and A8: $\alpha = .46$) groups. The internal consistency of the A3 and A8 tests was higher in the expert group, and it seems that consistency was better when there were fewer alternatives from which to choose the stroke response.

Two tests presumably sampling the same material are used when establishing reliability by using the parallel-form method (Thomas & Nelson, 1996). In the advanced test, the scores of the A3 and A8 test were correlated using Pearson´s correlation coefficient. The correlation coefficient between the tests A3 and A8 ($r = .81$, $p < .001$) was high only in the expert group, verifying the suitability of the advanced test for the expert group.

The reliability of the advanced test was determined by the test-retest method in the expert group for both tests and in the novice group for the A3 test. The correlation coefficients between repeated measures of TAP were high and significant in the expert group (A3: $r = .78$, $p < .001$ and A8: $r = .78$, $p < .001$) and low but significant in the novice group (A3: $r = .30$, $p < .05$). This implies that in the expert group the stability was high and almost identical in both tests.

6 RESULTS 2: Applying the instruments

The second section of the results presents the findings related to the research problems 2, 3 and 4 of this study (PHASES 2 and 3). The research problems will be examined separately due to differences in the settings and participants.

6.1 Age-related differences in game understanding and game performance at primary school level

6.1.1 Problem setting

Age group differences in decision-making in children have not been widely examined. Nevertheless, McMorris (1999) has proposed that teaching decision-making should follow Piagetian stages, according to which children at the concrete operations phase (7-11 years) are able, among other things, to use rules for thinking even though the decisions that can be made at this stage are still fairly simple. According to Piaget (1952) a more systematic approach to problem solving is not developed until the formal operations phase (11 years onward). In teaching games, attention has recently been paid to teaching the tactical aspects of the game earlier. It has been suggested by Werner et al. (1996) that modified games, which contain the same essential tactical structures as the official game but are played with adaptations to suit the size, age and ability of children, could be used for this purpose. Therefore, in this study the measurement instruments developed in Studies I and II were now applied to primary school children in order to evaluate the level of their game understanding in badminton and to compare their game performance in two types of net games.

6.1.2 Setting and participants

Primary school children in two different age groups, 9-year-olds (girls n=5 and boys n=5) and 12-year-olds (girls n=5 and boys n=5), served as subjects. The subjects played two types of net games on a standard badminton court: singles badminton (BA) and a modified throwing-catching game (TC) for 2 x 5 minutes against different opponents. No strategic or tactical advice was given during the matches and all matches were video recorded for further analysis. Subjects also participated in a basic game understanding video test (B) in order to assess their game understanding in badminton.

6.1.3 Results

An independent t-test of the game understanding video test scores showed that there was no significant difference in total amount of points between the age groups of 9 and 12 years (54.0±16.4 and 58.9±9.4 points, respectively). The video test scores were between 46 and 54% of the maximum (114 points) and almost the same in both age groups.

The means and standard deviations of the selected game analysis variables are shown in Table 14. A 2-way ANOVA was applied to study the differences in the descriptive game analysis variables in the different age groups and game forms.

TABLE 14 Selected means and S.D. values in the different age groups and games.

	Badminton		Throwing-catching	
	9-10 (n=10)	12-13 (n=10)	9-10 (n=10)	12-13 (n=10)
Effective playing	153.1	286.0	195.6	221.4
time (ET) (s)	(50.3)	(56.8)	(61.0)	(61.8)
Amount of shots	64.2	107.2	44.9	63.4
(AS)	(17.5)	(17.3)	(13.2)	(22.4)
Distance travelled	102	189	68	130
(DT) (m)	(39)	(31)	(27)	(61)
Length of shots	454	546	453	505
(LS) (cm)	(41)	(62)	(78)	(77)
Successful shots	78.7	90.5	89.0	93.6
(SU) (%)	(9.5)	(4.3)	(11.6)	(6.5)
Unforced errors	18.1	8.8	8.9	4.6
(UE) (%)	(9.8)	(5.2)	(9.2)	(6.1)
Use of deception	0.4	0.3	7.2	19.5
(UD) (%)	(0.8)	(0.7)	(6.1)	(18.1)
Cooperative shots	16.9	25.0	24.0	10.8
(CO) (%)	(10.8)	(12.4)	(15.3)	(10.7)

The results indicated significant main effects in ET for age $F(1, 36) = 18.94$, $p<.001$, and interaction $F(1, 36) = 8.63$, $p<.01$; in AS for age $F(1, 36) = 29.52$, $p<.001$, game $F(1, 36) = 31.07$, $p<.001$ and interaction $F(1, 36) = 4.68$, $p<.05$; in DT for age $F(1, 36) = 31.60$, $p<.001$ and game $F(1, 36) = 12.66$, $p<.01$, with no significant interaction, and in LS for age $F(1, 36) = 11.89$, $p<.01$, with no significant game or interaction effects. When analyzing the quality of game play, significant main effects were found in SU for age $F(1, 36) = 9.46$, $p<.01$ and game $F(1, 36) = 6.30$, $p<.05$, with no significant interaction; in UE for age $F(1, 36) = 7.58$, $p<.01$ and game $F(1, 36) = 7.40$, $p<.05$, with no significant interaction; in UD for age $F(1, 36) = 4.16$, $p<.05$, game $F(1, 36) = 18.55$, $p<.001$ and interaction $F(1, 36) = 4.24$, $p<.05$, and in CO for interaction $F(1, 36) = 7.35$, $p<.05$.

TABLE 15 Selected means and S.D. values in the different age groups and games.

	Badminton		Throwing-catching	
	9-11 (n=10)	12-13 (n=10)	9-11 (n=10)	12-13 (n=10)
Serve	46.3	21.1	45.4	43.9
(SE)	(14.2)	(5.9)	(12.2)	(9.2)
Clear	35.2	54.6	22.3	25.3
(CL)	(8.9)	(10.0)	(15.9)	(14.5)
Drop	17.4	18.2	22.5	20.7
(DR)	(15.8)	(5.9)	(15.8)	(16.4)
Smash	1.2	6.2	9.8	10.0
(SM)	(1.7)	(8.0)	(11.73)	(7.6)

The percentages of different shots used in badminton and the modified game can be seen in Table 15. A MANOVA for different shots/throws revealed significant main effects for age $F(1, 36) = 6.88$, $p<.01$, game $F(1, 36) = 9.17$, $p<.001$ and interaction $F(1, 36) = 5.06$, $p<.01$. Separate ANOVAs for different shots/throws revealed a significant main effect in SE for age $F(1, 36) = 15.12$, $p<.001$, game $F(1, 36) = 10.26$, $p<.01$ and interaction $F(1, 36) = 11.90$, $p<.01$, in CL for age $F(1, 36) = 7.83$, $p<.01$, game $F(1, 36) = 27.6$, $p<.001$ and interaction $F(1, 36) = 4.17$, $p<.05$, and in SM for game $F(1, 36) = 6.00$, $p<.05$, with no significant age or interaction effects.

Statistically significant correlations were found between the game understanding and game performance variables in badminton as follows; in all the subjects (N=20) between TAP and SU ($r=.56$, $P<.01$), in the age group 9-10 years between TAP and SU ($r=.67$, $P<.05$), and in the age group 12-13 years between TAP and CO ($r=-.69$, $p<.05$).

6.2 Expert-novice comparison

6.2.1 Problem setting

As the results of the previous age group comparison suggest, age was not a discriminating factor in game understanding. This was in accordance with earlier findings concerning age differences and decision-making in sport (McPherson & Thomas, 1989; French et al., 1996c) that strongly support the notion of domain-specific development. The goal of sport-specific research in games has been to understand the development of expertise in different sport contexts and to find out how cognitive and skill execution components of performance combine and interact. Therefore, Study III was designed to examine how experts and novices differ in game understanding, specific sport skills and actual game performance in badminton, and what the relationships between these variables are.

6.2.2 Methods

The subjects in this study were secondary school children and junior badminton players. Experts were defined as advanced badminton players who were chosen for the Finnish Badminton Association´s (FBA) training group (13-14 years of age), and who also had tournament experience (N=12). Novices were defined as beginning players in the corresponding age group who had little experience in badminton and no tournament experience (N=14). The subjects were tested for skill, game play and game understanding (A3), using instruments that were developed for this purpose. Skill tests and badminton matches took place on the badminton courts of a sports hall and the game understanding test was carried out in a classroom situation. Tables 16 and 17 represent the descriptions of the dependent variables to measure game play.

TABLE 16 Description of the dependent variables to measure game play.

Variable	Description
Percentage of Successful shots	Total number of shots coded as successful divided by the total number of shots x 100
Successful offensive	Total number of offensive (drop, net drop and smash) shots coded as successful divided by the total number of offensive shots
Successful defensive	Total number of defensive (lob and clear) shots coded as successful divided by the total number of defensive shots
Percentage of Forceful shots	Total number of shots coded as forceful divided by the total number of shots x 100
Forceful offensive	Total number of offensive (drop, net drop and smash) shots coded as forceful divided by the total number of offensive shots
Forceful defensive	Total number of defensive (lob and clear) shots coded as forceful divided by the total number of defensive shots

TABLE 17 Coding procedures for successful execution, errors and forceful execution.

Successful execution	Error	Forceful execution
Code as 1 1. Successful shot – rally continues 2. Successful shot – into the court	Code as 1 1. No error	Code as 1 1. Successful shot - into the target areas Code as 0 2. Successful shot – out of the target areas
Code as 0 1. Unsuccessful shot – off the court 2. Unsuccessful shot – into the net	Code as 0 1. Forced error 2. Unforced error	

6.2.3 Results

Skills

Experts performed significantly better than novices in both the long-serve test (18.3±10.3; 1.4±3.1, p<.001) and the clear test (17.5±11.8; 1.1±2.9, p<.001). The test for the drop shot was excluded from the analysis due to its inability to discriminate between the groups. Experts exhibited more sport skill, in other words, they were better at placing the shuttle on the target from the standing position (serve) and from movement (clear).

Game Performance

The game analysis revealed that experts played significantly more shots (213±28; 171±36, p<.01), played more from the backhand side (41.3%±7.3%; 17.1%±7.5%, p<.01) and directed the shuttle more often cross court, whereas novices played more straight shots (63.0%±13.7%; 47.9%±7.1%, p<.001). In addition, experts played longer shots (790 cm ± 33 cm; 609 cm ± 105 cm, p<.001) and travelled a longer distance on the court (746 m ± 92 m; 305 m ± 75 m, p<.001) when compared to novices. On the other hand, no significant differences were found when comparing the effective playing times between these groups. The differences in the type of shots used in the game are shown in Figure 16. As can be seen, serve and clear were the most commonly used shots, and novices based their game mostly on these shots (67.7%), whereas experts also used other shots such as drop shot, lob, net drop and smash.

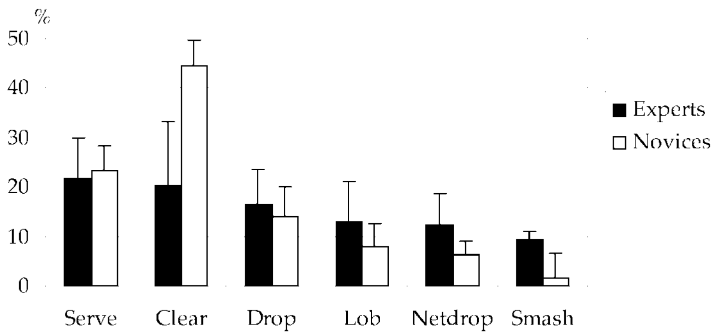

FIGURE 16 Different types of shots used by experts and novices.

Experts had a lower success percentage in all the shots (87.3%±2.6%; 90.0%±4.4%, p<.01), as well as in successful offensive (79.8%±9.3%; 83.6%±11.8%, p<.001) and successful defensive (90.7%±4.8%; 92.1%±4.1%, n.s.) shots, when compared to novices. On the contrary, when the quality of the shot execution was observed, it was revealed that experts used more forceful shots (65.1%±8.0%; 7.2%±9.6%, p<.001), as well as more forceful offensive (58.2%±11.2%; 13.0%±12.0%, p<.001) and defensive (43.7%±11.6%; 5.7%±13.5%, p<.001) shots, when compared to novices. As can be expected, both groups made more errors and used more forceful shots in their offensive play. The skill level of the novice players was still undeveloped, which could be seen in their inability to produce forceful shots, and therefore, the main focus in their game was to hit the shuttle over the net directly to their opponent and to keep the shuttle in play. On the other hand, the skill level of the expert players enabled them to use more forceful shots and different types of shots in order to move their opponents out of position to win a rally.

Game Understanding

A t-test was applied to detect differences between experts and novices, and the results showed that there were significant differences between these groups in all the variables in the game understanding test (Table 18).

TABLE 18 Comparison of the video test scores between the groups.

	Expert (n=12) M	Novice (n=14) M	t value	ES
Selected shot option (SSO)	19.7 (3.5)	16.1 (2.6)	3.02**	1.24
Selected argument option (SAO)	30.1 (21.2)	5.3 (9.9)	3.91**	1.60
Total amount of points (TAP)	49.8 (22.5)	21.4 (11.2)	4.16***	1.70

Note. Standard deviations are given in parentheses.
*p<.05. ** p<.01. *** p<.001.
M: Mean; ES: Effect size

Differences between the groups were further investigated by calculating effect sizes to determine the meaningfulness of the group differences, by using pooled standard deviations (Thomas & Nelson, 1996). As can be seen in Table 18, effect sizes (ES) ranged from 1.24 to 1.70. According to Thomas & Nelson (1996), ES <.40 is considered low, <.80 moderate and over .80 high, and therefore, the differences between experts and novices in this study can be considered meaningful.

In considering the video test based on the different kinds of situations (offense, defense and neutral), more detailed information about the differences between the groups was found. A significant difference between experts and novices was found in SSO in the defensive (8.2±2.2; 5.9±1.8, p<.01) and neutral (2.6±0.5; 2.0±0.7, p<.05) situations, in SAO in the offensive (19.9±11.9; 10.6±7.8, p<.05) and defensive (16.6±8.8; 9.6±6.4, p<.05) situations and in TAP in the offensive (28.8±12.6; 18.8±8.5, p<.05) and defensive (24.8±10.2; 15.5±7.6, p<.05) situations.

Badminton Skills, Performance and Game Understanding

Correlations between skill, game play and game understanding variables in all the subjects are shown in Table 19. The percentage of forceful shots was strongly related to both skill and game understanding, whereas no significant correlations were found between all successful shots, skill and game understanding. In other words, players that used forceful shots to make their opponent move also had a higher skill level and achieved higher scores in the video test, thus demonstrating better understanding of the game. Skill and game understanding were also related, showing that individuals who achieved higher scores in the skill test also made better decisions in the video test.

TABLE 19 Correlations between skill, game play and game understanding variables in all the subjects.

	SS	FS	TAP
Successful shots (SS)			
Forceful shots (FS)	-.35		
Total amount of points (TAP)	-.08	.62**	
Skill test score (ST)	-.25	.89***	.73***

*p<.05. ** p<.01. *** p<.001.

TABLE 20 Correlations between skill, game play and game understanding variables in experts and novices.

	Experts n=12			Novices n=14		
	SS	FS	TAP	SS	FS	TAP
Successful shots (SS)						
Forceful shots (FS)	-.20			.07		
Total amount of points (TAP)	.26	-.40		.27	.51*	
Skill test score (ST)	.62*	-.12	.52*	-.13	.65**	.11

*p<.05. ** p<.01. *** p<.001.

As can be seen in Table 20, the more skillful expert players also had more successful shots and a better understanding of the game, whereas in novices more efficient game play was related to higher skill and game understanding test scores. Multiple regression analysis (stepwise) was applied to study the amount of explained variance by skill and game understanding scores on game play. In experts, ST was found to be related to all successful shots ($R=.62$, $R^2=39$, $\beta=.62$, $F=6.28$, $df=11$, $p<.05$). This finding indicates the importance of the high skill level on game playing ability and understanding.

In novice players, ST ($\beta=.65$) and TAP in offensive situations ($\beta=.52$) were accepted as being related to all forceful shots ($R=.83$, $R^2=69$, $F=12.34$, $df=13$, $p<.01$), and TAP in defensive ($\beta=.65$), ST ($\beta=.51$) and in offensive ($\beta=.42$) situations was accepted as being related to forceful defensive shots ($R=.92$, $R^2=85$, $F=18.23$, $df=13$, $p<.001$). It seems that in novices both the skill level and understanding of the game lead to more effective game play.

6.3 Intervention study

6.3.1 Problem setting

Some preliminary evidence of short instructional studies (French et al., 1996; McPherson & French, 1991; McPherson, 1994) supports the assumption that the focus of practice and instruction affects what aspects of performance are acquired. In Study III the results indicated that skill, game play and cognitive components all differentiate experts from novices. More research, on the other hand, is needed to understand what types of instructional interventions produce specific types of learning. Therefore, the purpose of Study IV was to examine the effects of two forms of instruction, "traditional" and "traditional" plus video-based strategy instruction, on students´ knowledge, game understanding, skill and game performance, and to compare these groups to a control group not receiving any badminton instruction.

6.3.2 Methods

Participants

The participants for this study were college students (n = 30) in a teacher-training program at the University of Jyväskylä. All students had moderate previous experience in badminton from a racket games unit in their first year of studies and a background of athletics, gymnastics, skiing and playing invasion games. None of the students had played competitive badminton at any level. Students in the two experimental groups (n = 21) participated in a "Specialized course in teaching various sports", which consisted of 20 lessons of badminton instruction, 8 lessons of game play, 8 lessons of video-based tactical training and 4 lessons of pre- and posttest measures. After attending the first badminton instruction unit (20 lessons), students were randomly assigned to two treatment groups: "Course plus Video-Based Strategy Instruction (Strategy-oriented)" (age mean = 25.3, SD = 1.2 years; males (n = 8) and females (n = 3)) and "Course Only (Traditional)" (age mean = 27.4, SD = 3.4 years; males (n = 7) and females (n = 3)). A group of students (n = 9) not participating in the program volunteered to serve as a control group (age mean = 22.8, SD = 1.3 years; males (n = 6), females (n = 3)). The teacher of the badminton unit had ten years of coaching and teaching experience in badminton and the researcher served as his assistant in testing and teaching situations.

Treatments

The total treatment time was six weeks and at the beginning of the unit, the experimental groups (Strategy-oriented and Traditional) received 20 lessons (45 minutes each) of badminton instruction during two weeks, approximately 10 lessons per week. The first 2 lessons consisted of introducing the unit, badminton knowledge and rules, and the other 18 lessons focused on badminton skills (i.e., serve, clear, drop, net drop, smash and smash return), movement techniques and tactical instruction taught on a badminton court. The skill tasks were presented using direct instruction, followed by extension and refinement tasks for the skill. Combination tasks were also used in order to practice a particular strategy by using a sequence of strokes. All instruction dealt with the game of singles badminton and feedback was provided for both skills and tactics during practice and game performance. The control group did not participate in this treatment, but was enrolled instead in a normal ball games unit during this time.

In the next four weeks, the experimental group was divided into two treatment groups (Strategy-oriented and Traditional), both of which played singles badminton for 45 minutes two times a week. The students were asked to choose an opponent of similar ability inside their own treatment group and they were also allowed to change the opponent. In addition, the strategy-oriented group received 8 lessons of tactical instruction, approximately 45 minutes two times a week, whereas the traditional group did not receive any instruction on tactics during the 4-week period. The tactical instruction consisted of video tasks that were designed to enhance the game understanding of students by provoking critical thinking and problem solving, and thereby also developing their decision-making ability.

The video tasks were divided into three different parts based on different areas of the court: front court, center court and backcourt. Offensive and defensive game situations were shown to the participants and different types of questions were asked, including the recovery position, stance of the racket, movement on the court and decision-making alternatives in different situations. An example of the video tasks is shown in Figure 17 and the corresponding arguments are listed in Table 21.

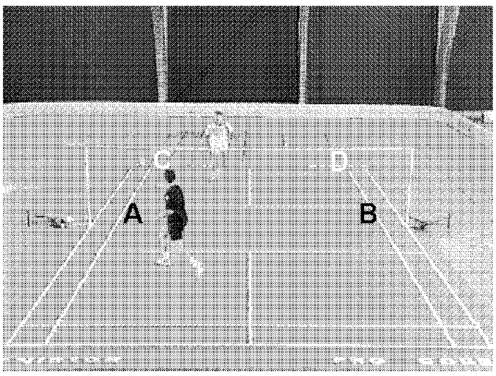

FIGURE 17 An example of the video task.

These particular tasks started with a live video for 3-7 seconds and were then followed by a still frame representing four possible stroke options. The task was to put the stroke options in order from the best to the worst strategic stroke and give explanations (as if-then productions) on why they chose this specific order for the stroke options. All the questions were discussed during the last 15 minutes of the treatment session, after finishing the video tasks, in order to give feedback to the students on the selections they made. The video tasks were shown on seven separate sessions and the last session was reserved for the researcher to summarize all the material.

TABLE 21 Selected stroke options and positive and negative arguments in the video task example.

Stroke option	Arguments
A	+ because opponent has to move a long distance + because opponent has to change direction + because shuttle is high on the net + because this is an easy stroke to perform
B	+ because opponent has to move as long distance as possible + because shuttle is high on the net - because it gives more time to the opponent - because this is a more difficult stroke
C	+ because opponent is too anxious to return to home base + because shuttle is not passing through opponent´s home base - because opponent has time and opportunity to cut the stroke
D	+ because it is opponent´s backhand side - because opponent has the longest possible time to reach the shuttle - because shuttle is passing through opponent´s home base

Testing Procedure

The participants were tested for badminton knowledge (McGee & Farrow, 1987), game understanding (A3), skill (Sipiläinen et al., 1997) and game performance using instruments that were developed for these purposes. Skill tests and badminton matches took place on the badminton courts of a sports hall, and badminton knowledge and game understanding tests were administered to all students in a regular classroom by one of the experimenters. Tables 22 and 23 represent the definitions of the dependent variables to measure game play and a list of all dependent variables and possible scores.

TABLE 22 Definitions of the dependent variables to measure game play.

Variable	Definition
Successful shot	Hit within the boundaries of play
Forceful shot	Hit into the target area
Cooperative shot	Hit straight to the opponent – nontactical

TABLE 23 A list of dependent variables and possible scores.

Dependent variables	Possible scores			
Knowledge	Total (KT)			
Game understanding	Strokes (SSO)	Arguments (SAO)	Total (TAP)	
Skill	Serve (SE)	Clear (CL)	Drop (DR)	Total (ST)
Game performance %	Successful (SU)	Forceful (FS)	Cooperative (CO)	

6.3.3 Results

Analysis of Knowledge

A repeated measures ANOVA for badminton knowledge indicated a significant main effect for time, $F(1, 27) = 9.10$, $p<.01$ and a significant interaction, $F(2, 27) = 5.47$, $p<.05$. No significant main effect for group was found. As shown in Figure 18 the strategy-oriented group was able to improve its badminton knowledge more than the other groups. The difference between the strategy-oriented group and the control group in the posttest situation (3.62 points) was significant ($p<.05$). Table 24 provides a summary of the means and standard deviations for the knowledge and game understanding variables.

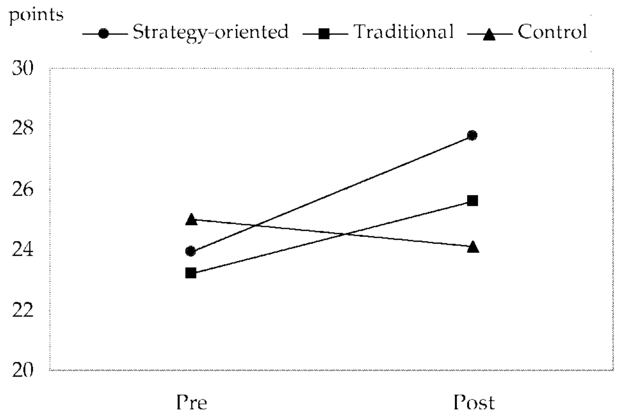

FIGURE 18 Pre- and posttest scores of the knowledge test in different groups.

TABLE 24 Summary of means and standard deviations for knowledge and game understanding variables.

Variable	Strategy-oriented		Traditional		Control	
	Mean	S.D.	mean	S.D.	Mean	S.D.
Pretest						
Knowledge	23.91	2.81	23.20	5.85	25.00	3.67
Selected shot options	16.36	3.59	17.60	2.68	18.11	4.08
Selected argument options	25.09	6.55	28.80	7.39	27.00	8.47
Total amount of points	41.45	8.54	46.40	8.73	45.11	12.30
Posttest						
Knowledge	27.73	2.49	25.60	3.98	24.11	3.26
Selected shot options	19.00	2.19	18.10	2.77	19.44	3.00
Selected argument options	34.27	4.63	31.70	6.22	27.78	8.64
Total amount of points	53.27	5.93	49.80	6.94	47.22	10.54

Analysis of Game Understanding

A repeated measures ANOVA for game understanding revealed a significant main effect for time in SSO; $F(1, 27) = 4.32$, $p<.05$ and in TAP; $F(1, 27) = 10.09$, $p<.01$. No significant main effect for group or interaction was found. In SAO a significant main effect for time, F(1, 27) = 10.25, p<.01 and a significant interaction, F(2, 27) = 3.66, p<.05 were found. No significant main effect for group was found. As can be seen in Figure 19 the strategy-oriented group was able to improve its game understanding more than the other groups. The difference in SAO between the strategy-oriented group and the control group in the posttest situation (6.50 points) was significant (p<.05).

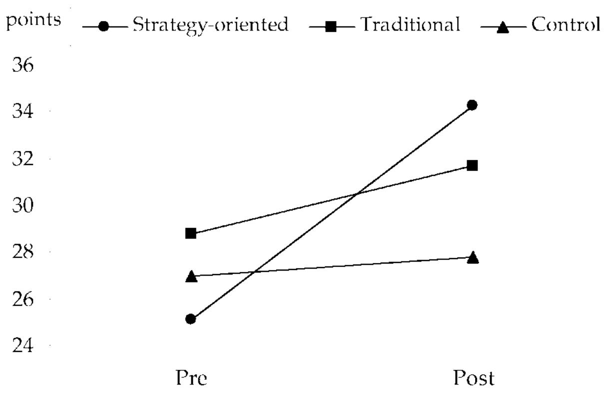

FIGURE 19 Pre- and posttest scores of SAO in different groups.

Analysis of Skill

A MANOVA for skill test scores (serve, clear and drop) revealed a significant main effect for time F(1, 27) = 3.31, p<.05 and a significant interaction F(2, 27) = 2.77, p<.05. Separate ANOVAs for skill test scores revealed significant main effects in SE for time F(1, 27) = 9.79, p<.01 and for group F(2, 27) = 3.94, p<.05, and a significant interaction F(2, 27) = 8.06, p<.01.

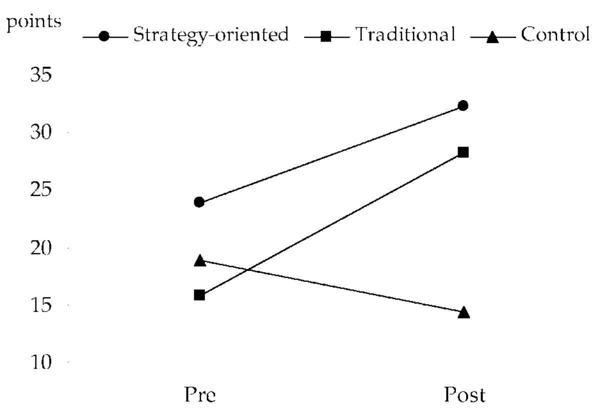

FIGURE 20 Pre- and posttest scores of the serve skill test in different groups.

A Bonferroni post hoc analysis indicated that the strategy-oriented group was significantly better (p<.05) in the serving skill when compared to the control group. As shown in Figure 20, the traditional group was able to improve its badminton serving skill the most when compared to the other groups. The differences between both treatment groups and the control group in the posttest situation were significant, being 17.83 ($p<.001$) and 13.76 ($p<.01$) points higher in the strategy-oriented and in the traditional group, respectively, than in the control group.

Analysis of Game Performance

A repeated measures ANOVA for game performance revealed a significant main effect for group $F(2, 27) = 3.47$, $p<.05$ only in cooperative shots, with no significant main effects for time or interaction. A Bonferroni post hoc analysis indicated that the strategy-oriented group played significantly fewer cooperative shots than the control group. Table 25 provides a summary of the means and standard deviations for the selected skill and game performance variables.

TABLE 25 Summary of means and standard deviations for skill and game performance variables.

Variable	Strategy-oriented		Traditional		Control	
	mean	S.D.	mean	S.D.	mean	S.D.
Pretest						
Serve test	23.91	11.79	15.80	7.51	18.89	12.21
% Successful	87.35	5.12	86.27	4.80	89.45	5.50
% Forceful	48.93	17.98	35.43	17.26	28.65	22.22
% Cooperative	17.90	9.64	27.83	12.61	34.68	20.42
Posttest						
Serve test	32.27	7.98	28.20	11.57	14.44	9.71
% Successful	86.80	5.33	86.41	5.79	86.88	5.11
% Forceful	45.96	11.16	46.09	32.12	29.50	22.07
% Cooperative	17.81	6.77	24.95	11.31	32.35	19.10

7 DISCUSSION

The acquisition of sport-specific cognitive and motor skills that underlie expertise especially in high-strategy sports begins in childhood and continues throughout adolescence. Both biological and experiential factors can either facilitate or limit the development of these skills. The present study investigated the multiple nature of game performance in badminton, concentrating especially on the cognitive aspects of game performance. The primary goal was to develop valid and reliable instruments to evaluate both cognitive and skill-related aspects of game performance. The aim of this section is to discuss the results of the current study concerning the development and validation of the instruments (PHASE 1), their application to different age and experience levels (PHASE 2), as well as the intervention study (PHASE 3) designed to enhance both cognitive and motor skills of physical education students.

7.1 Primary findings

The primary findings in the present study were as follows:

1. The overall results of the first validation study indicated that significant intra- and inter-observer correlations were found in all the game analysis variables, with higher correlations in quantitative and lower in qualitative variables.

2. The findings of the second study suggested that the video-based game understanding test procedure developed provides a valid and reliable method for assessing game understanding in badminton.

3. The results of the third study clearly showed that skill, game play and cognitive components all differentiated experts from novices. Experts

exhibited significantly more sport skill, played more effective shots and understood the game situations better when compared to novices.

4. The findings of the fourth study revealed that the strategy-oriented group was able to improve its badminton knowledge and game understanding significantly, whereas the traditional group improved only its badminton serving skill.

7.2 Instrument development

Notational analysis system

In the first phase of this study, a full match of singles badminton was notated for validation purposes by using the computer-based analysis system developed for this study. The system is comparable to those systems used by Hughes and Clarke (1995) and Brown and Hughes (1995) to analyze tennis and squash. The match was analyzed by three trained observers who all coded the whole match twice. The intra- and inter-observer reliability of all the variables was calculated in order to detect discrepancies between and within observers. The overall results of this validation study indicated that the notational analysis system was valid and reliable for evaluating the type of shots, the positional and temporal variables as well as the outcome of the shot, but it was less reliable when the quality, e.g. execution and decision of the shot, was concerned.

The highest intra-observer agreement level in the selected shots was found in the serve, lob and smash return and between the observers in the lob and smash return (100%). Similar agreement levels were also found by Hong et al. (1998) in categorizing 13 different squash shots (100%) and Eom and Schutz (1992) in evaluating six different skills in volleyball ($r = .90$). The variability in the selected shots in this study was highest in the drop shot (15.5%), although it was still acceptable. Of the other qualities of the shots, the height was the most difficult quality to observe.

Some differences were also found in the correlation coefficients of the positional variables: length of the shot, receiver´s placement and total distance travelled by a player. Evaluating the length of the shot was more accurate than evaluating the calculated value of the total distance travelled. Both intra- and inter-observer correlation coefficients indicate that in evaluating the receiver´s placement, the correlations were higher in the y-direction, which means that lateral movement was easier to observe. In the temporal variables the correlations were higher in the total playing time than in the effective playing time. It seems that observing the playing time in this study was as accurate as in Liddle and O´Donoghue´s (1997) study, despite of the different method used.

When analyzing the quality of the shot the highest intra- and inter-observer correlations were found in evaluating the outcome of the shot, and the lowest in evaluating the shot decision. The correlations in this study in analyzing the quality of skill execution are lower when compared to Eom and Schutz´s (1992) findings in volleyball.

Even though different measurement strategies can be used to evaluate game performance (Godbout, 1990), the most valid measure of game play is the quantitative and qualitative information that is driven from an actual game. The notational analysis system developed and validated in this study seems usable for all teaching, coaching and research purposes, however, some further attention needs to be paid to the qualitative side of decision-making and execution that also need to be assessed. It also seems to be applicable to all the areas of application of notation presented by Hughes (1998). Through tactical evaluation, different patterns of play can be identified and changes in tactical models can be observed. Similarly, the technical evaluation gives detailed quantitative data of the different shots that can be used to recognize the strengths and weaknesses of a player. A movement and time analysis can be used to analyze the intensity of the game and the players´ positions and movements on the court, thereby creating better understanding of the game´s demands. The development of a database is enabled by collecting a sufficiently large amount of data, which can then be used to define "profiles" or "norms" of behavior for certain types or standards of players.

From the perspective of this study, the most important area of application is nevertheless the educational use of the notational analysis system. Assessing pre- and posttest game performance by videotaping matches before and after the treatment/training period could be used to detect changes in game play. Furthermore, educators can use this procedure in training students to understand and evaluate different aspects of game performance and to reflect on their own performance. For student observation in the physical education context the system seems to be too complicated and needs to be modified in the direction proposed by Grehaigne, Godbout and Bouthier (1997) and Oslin et al. (1998). This would mean simplifying the coding procedure by reducing the number of components being evaluated and focusing only on some fundamental aspects of game play (e.g., decisions made, skill execution, and support). These modifications would allow this instrument to be used either by teachers or students during physical education lessons.

Game understanding tests

In addition, in the first phase of this study, video-based test procedures for badminton were tested to determine their degree of validity and reliability for assessing game understanding. Unlike in many other studies that measure decision-making skills (e.g., Starkes, 1987; Tenenbaum, et al., 1993; Thiffault, 1980; Yaaron et al., 1997), three types of validity; content, construct and criterion validity, and three types of reliability; internal consistency, parallel-form and stability were examined in this study.

When higher cognition is required in a test and it also requires analysis and synthesis, as in this study, the test is usually more difficult to develop. The multiple choice items and the best answer variation used in this study (meaning that one answer is preferable and that other choices have a degree of correctness, but are not the best possible response) are, according to Barrow et al. (1989), suitable techniques in strategy and skill technique questions. Based on the fact that some attributes are easier to measure than others, it is also quite obvious that some types of tests have better potential for high reliability, such as physical fitness tests (r ≈ .95). Others, such as the method used in this study as well as observation methods (r ≈ .60) (van der Mars, 1989) and psychological tests (r ≈ 0.75-0.80) (Coolican, 1994), have lower reliability even when everything is done correctly.

Similar to some previous studies (e.g., McMorris and Graydon, 1996; 1997; McMorris and MacGillivary, 1988; Marriot et al., 1993; Tenenbaum et al., 1993; Yaaron et al., 1997), experts were also used in this study to select the content of the test, and thereby, the content validity in all tests was verified. Construct validity, on the other hand, has not been commonly used when validating decision-making tests. Nevertheless, the results clearly showed that the tests were able to detect differences between the groups in each game understanding variable, and thus the requirements for construct validity were also achieved. A similar technique to verify construct validity was also used by Oslin et al. (1998) and Richard et al. (1998) to validate instruments (GPAI and TSAP) that measure game performance. Even though other measures of validity were at a satisfactory level, criterion validity of the advanced test could have been improved. The level of criterion validity in this study was lower when compared to Thiffault´s (1980) results in ice hockey, correlating on-ice and tachistoscopically presented decision-making tests (r = .75) and to McMorris and MacGillivary´s (1988) findings in football, correlating coaches´ assessment of decision-making performance and performance in a decision-making test constructed of tachistoscopically presented slides (r = .74).

In terms of reliability, the internal consistency was acceptable in the basic test for all the participants and in the advanced test for the expert group. These findings are parallel to McMorris and MacGillivary´s (1988) study, presenting an Alpha value of .71 in their test for soccer players. The stability of the advanced test was shown to be acceptable in the expert group, being higher than the reliability coefficient (r= .70) reported by Thiffault (1980). The results of the parallel-form measures of the advanced test revealed high and significant correlations between the tests A3 and A8 in the expert group and affirmed thus the assumption of the test´s adequacy in the expert group.

The tests reported in this study have the advantage that they are easy to use and they allow for large groups to be tested at the same time. The tests are also useable at two different performance levels; the basic test was found to be a valid and reliable instrument in assessing game understanding in novices and the advanced test in more experienced players. Of the advanced tests, A8 was found to be more difficult when compared to A3, and thus, it could be more sensitive in detecting differences between the different levels of expert players. It could also be beneficial to use this type of a procedure together with other forms of game performance assessment instruments, such as the GPAI or TSAP introduced by Oslin et al. (1998) and Grehaigne and Godbout (1998a). This would give an additional insight into how the cognitive processes transfer to actual game performance and at the same time what kind of understanding is still processed on the cognitive level.

The overall findings of this study support the idea that it is important to control the experience level for which the test is applied. There are at least two explanations for why the reliability of the advanced test was diminished among novices. First, the experts´ possibility to practice and learn the cognitive and motor skills results in higher degree, more organized and structured domain-specific knowledge, and therefore, they process the knowledge and problem solving differently from novices (Rink et al., 1996b; Thomas et al., 1986). These earlier findings were supported in this study by establishing that experts were more accurate and consistent in choosing their shot response alternatives and arguments when compared to novices. Second, even though the earlier findings on the effect of skill level on decision-making are contradictory (French & Nevette, 1993; McPherson & Thomas, 1989), the results of this study showed that novices were unable to consistently select the appropriate alternatives and arguments. This further confirms the assumption that the test must be appropriate for a specific level.

7.3 Instrument application

In the second phase of this study, game understanding and game performance of primary school children in two types of net games were firstly examined. The results of the age group comparison revealed that the age groups did not differ in game understanding, whereas in game performance the older age group was more successful in both games.

The game understanding test scores implied that the basic tactical ideas in badminton were partly understood even though the subjects had only little experience in badminton. These findings seem to be in agreement with Piaget´s (1952) theory of cognitive development, according to which children of this age are at the phase of concrete operations and are able to think through a series of events or actions. Thus, the children were capable of understanding the 1 v 1 situations of the basic test in badminton and were able in some situations to determine what happened and why.

In game performance, on the other hand, the older age group was more successful in both games. As has been stated by Thomas et al. (1993), motor skills generally improve across childhood, and therefore, these findings were predictable. The older age group played badminton quite cooperatively, playing 25% of all their shots straight towards their opponent without using any deceptive shots, whereas in the modified game they played more competitively and were able to use deception in their throws. Based on the descriptive game analysis variables in badminton it could be argued that the younger subjects were not even at the cooperative stage of learning and were just trying to hit the shuttle over the net. In contrast to this, the younger subjects seemed to be more successful in playing the modified game and were able to apply their tactical understanding by using some deceptive throws. These findings are in accordance with Bunker and Thorpe´s (1982) suggestion that teachers should use modified games in order to allow children to practice the tactical aspects of the game.

When examining the relationship between game understanding and game performance in badminton, the cognitive skills were found to be related to game performance in both age groups. In the younger age group the cognitive skills were more related to technical aspects of the game, in other words, those who understood the game were also more successful in their game play. In the older age group, on the other hand, the cognitive skills were related to tactical aspects of the game, and thus, those who had better tactical knowledge used less cooperative shots in their game play.

Secondly, the expert-novice comparison indicated that skill, game play and cognitive components all differentiate experts from novices. These findings support the notion of domain-specific development. Experts exhibited more sport skill, played more effective shots and understood the game situations better than novices. The results also showed that more effective game play (forceful shots) was related to both skill and game understanding, and that the more skillful players had a better understanding of the game. In experts, 39% of the variance in successful shots was explained by the skill test scores and in novices, 69% of the variance in forceful shots was explained by the total score of the skill test and the offensive situations in the video test.

Some of the typical features of expert performers in skill execution, such as higher scores on skill tests (Rink et al., 1996b), were also achieved in this study. The success rates for skill execution during game play were higher in novices, but the effectiveness of game play (forceful shots) was higher in experts. These findings speak of different styles of play. Novices tended to play a cooperative game, in which the main focus was to keep the shuttle in play and hit a low-force shot straight to the opponent. Experts, on the other hand, tried to move their opponent around the court and were more likely to hit the shuttle out of bounds or into the net, as found also by French et al. (1996b). Other descriptive game play variables such as the number and average length of shots, the total distance travelled by the player and the ability to use a variety of shots in the game further evidenced the better skill level and game play ability of experts.

The findings of this study concerning knowledge and decision-making skills are in agreement with other studies (e.g., French & Thomas, 1987; French et al., 1995; McPherson & Thomas, 1989; Thomas & Thomas, 1994) in which novices were unable to select appropriate actions due to their undeveloped procedural knowledge base. However, the experts of this study were more sophisticated in knowing when or under what conditions to select particular options. Their ability to select an appropriate alternative and to argue for the decision (i.e. condition-action link) implied better declarative and procedural knowledge. Consistent with Anderson´s (1983) theory, the experts were able to facilitate the transition from control by declarative knowledge to control by procedural knowledge through training and playing. Williams and Davids (1995) presented similar findings, in which playing experience facilitated the development of task-specific declarative knowledge, which on the other hand was effectively proceduralized through performance.

At least two factors, reported earlier by French et al. (1996c) and French & Nevette (1993), were identified that seemed to constrain the response selection ability: the motor skill level and the practice/game experience of players. Considerable variability in the scores of the game understanding video test in experts implies that experts were less homogenous as a group than novices, and that even though all players in the expert group were defined as experts, they clearly had different levels of game understanding. This could be due to differences in the amount of game playing and tournament experience, or in their practice backgrounds that stress different player characteristics (Thomas, 1994). Some players and coaches emphasize more practice of motor skill execution and less response selection, and vice versa. If a player seldom has to select from different decision alternatives, monitor game conditions, plan and generate solutions or predict potential actions, it may partially explain why he/she also fails to monitor critical game conditions in a test situation.

The relationships between the measured variables in this study suggested that successful game play in experts was related to skill level, and effective game play in novices was related both to skill and game understanding. Thomas & Thomas (1994) have also suggested that it is not always the same factors that lead to expertise; in some cases, skill limits game performance, whereas in other cases skill exceeds knowledge, or all these components could also be perfectly correlated.

In the third phase of this study, the effects of two types of instruction on badminton performance of physical education students were examined. After the 6-week treatment period the strategy-oriented group receiving separate video-based strategy instruction was able to improve its badminton knowledge and argumentation more than the traditional or control groups. In addition, both treatment groups improved their serving skill significantly when compared to the control group, and the strategy-oriented group played less cooperative shots than the control group.

The strategy-oriented group improved its badminton knowledge the most. This finding was in agreement with other similar studies (Griffin et al., 1995; Turner, 1996) in which the tactical groups scored higher on declarative knowledge. Argumentation in the game understanding test was also improved the most in the strategy-oriented group. Therefore, the use of video-based methods in developing students´ game understanding was found to be useful and the results were also consistent with other studies that have used similar methods in developing perceptual and anticipatory skills of athletes (Abernethy, Wood, & Parks, 1998; Christina, Barresi, & Shaffner, 1990; Farrow, Chivers, Hardingham, & Sachse, 1998; Starkes & Lindley, 1994).

Unlike in other studies (e.g., Griffin et al., 1995; Lawton, 1989), the skill test scores showed that both treatment groups improved their serving skill significantly over time when compared to the control group. This could partly be explained by the age of the students. Whereas Lawton (1989) and Griffin et al. (1995) used children, the students in this study were adults who could have had more experience on similar types of games. In the game performance variables the only significant difference was that the strategy-oriented group played significantly less cooperatively than the control group. Previous research comparing tactical and technique groups (Griffin et al., 1995; Turner, 1996; Turner & Martinek, 1992) has failed to find significant differences in the posttest game performance variables. Even though the present study evidenced only a few significant differences in the skill and game performance variables, a clear trend favoring both treatment groups was found in the serving skill, and cooperative and forceful shots.

7.4 Implications to games teaching and coaching

It is evident that response selection and decision-making must be learned, especially in high-strategy sports (Thomas, 1994) like badminton. Students and players should be encouraged to understand that effective games participation is contingent upon making appropriate decisions. Therefore, developing procedures should be one of the major goals of youth sport. Knowing "what to do?" and "why?" are important questions when trying to develop an appreciation of the major tactical considerations inherent in the game. The suggestion that general tactics will develop automatically, as a result of playing the game (Rink et al., 1996a), may be partly true, at least in less complicated games such as badminton. However, when more complex tactics are considered, it must be understood that good decision-making skills don´t occur at an optimal level by merely playing the game – they should be taught. At this stage, it is important that students acquire tactics as procedural knowledge of the game, in the form of if-then relationships, because responses in game situations are selected based on previous experience, facts and the current conditions (Thomas, 1994).

The questions of when and how decision-making is best taught are still partly unanswered and the results of this study do not directly add to this knowledge. However, the results suggest that 9-year-old children were able to understand the basic 1 v 1 situations in badminton and that maturation alone did not improve their decision-making ability considerably. On the other hand, consistent with earlier studies (French & Thomas, 1987; French et al., 1995; McPherson & Thomas, 1989; Nevett & French, 1997), the expert-novice comparison of this study revealed that highly skilled badminton players were more accurate and consistent in their decision-making when compared to novices. These findings clearly verify the importance of domain-specific knowledge in developing decision-making ability.

Teachers and coaches should always identify the developmental levels of their students in order to provide appropriate challenges. In the early stages of playing, shot selection and court position are the two basic conditions that guide players tactically. Students should develop the skills required for long and short shots and learn to concentrate on offense to set up an attack by creating space, i.e. students must learn to be aware of open areas on the court. In defense they need to learn to defend space on their own side of the net. Even though the secondary school children of this study played quite cooperatively, they were occasionally able to apply the basic strategies in net games.

Gradually, after acquiring the basic skills and tactics, more complex skills and tactics can be learned. In more advanced tactics, players try to reduce the options available to the opponent and are able to use a wide variety of different shots, like the expert players of this study, in moving their opponent out of position in order to win a rally.

If one of the goals in games teaching is to provide students with good decision-making skills, teachers and coaches can facilitate the building of more advanced knowledge structures by questioning and explaining the relations among game conditions, actions and goals. This could be implemented by using a tactical approach in teaching (Bunker & Thorpe, 1982). In this approach, a developmentally appropriate game form is used to expose students to specific tactical problems, thereby encouraging them to think tactically. Bunker and Thorpe´s (1982) model takes into account the developmental level of children. It seems obvious, based on empirical evidence, that in young children the teaching of games should begin from simple games and situations, and new problems should be introduced only after the simple ones are mastered. Based on the games classification system introduced by Almond (1986), the net and wall games category could be the most desirable place to start with. The 1 v 1 games like badminton and tennis, in which the players have limited alternate roles of striking or receiving, give students an opportunity to practice decision-making in actual game situations. In these games perceptual and cognitive demands are simple and there are only few cues to perceive.

Even though the basic tactical ideas in badminton were quite easy to understand in this study, the results of the game analysis revealed that in playing badminton the skill level of the students restricted the use of their tactical knowledge in both age groups at primary school level. On the contrary, in the modified game both age groups were able to use their tactical knowledge in playing the game. Therefore, if the children are unable to control the object, the skills must be modified to be developmentally appropriate, and made more difficult only after the children are ready for more challenge. Consistent with Doolittle´s (1995) suggestion, the results of this study also reinforce the idea that in the early phase of learning badminton it is important to use games in which the skills are modified to provide practice with the tactical challenges of the game.

Another way in which teachers and coaches can try to increase students´ knowledge base, and thereby enhance their decision-making ability, is to use video-based instruction, as in this study. The three types of settings, i.e. action, observation and debate-of-idea introduced by Grehaigne and Godbout (1998b), can also be identified from the procedure used in this study to enhance game understanding of P.E. students. Students were first engaged in the actual game play, after which they observed the typical game situations from the video, expressed themselves and exchanged facts and ideas based on their observations. It seems that the video-based learning tasks in this study, including problem solving and group discussions stimulated critical thinking and encouraged students to develop their tactical awareness. Through these processes the cognitive aspects of the game were brought to a conscious level of awareness even though the results did not clearly show the transfer of these skills to game play.

Finally, the game understanding tests developed in this study can also be useful adjuncts in learning tactics. At the expert level the participants have to process many possible solutions in every situation and find the strengths and weaknesses of each solution. A teacher or a coach can explain different strategies for the players and they can also be discussed (what works/does not work and why) (Thomas, 1994). At the novice level the basic tactical skills can be taught through video sequences. The children can be taught to notice differences between offensive and defensive strategies, how to create and defend space and how to establish a pattern in order to get their opponent out of position. The teacher can provoke critical thinking and problem solving by asking appropriate questions related to the goal of the activity, for example, what skills and movements, and why, must be used to achieve the goal and how to perform the necessary skills (Griffin et al., 1997). It has been shown by Gallagher & Thomas (1986) that even very young children can use different strategies to aid the working memory if the child is taught how to do so. Hence, the lessons should be designed to include a variety of game situations so that students use and practice cognitive processes such as monitoring game conditions (player´s own position, position of the opponent and shuttle), planning actions in advance and choosing among alternative actions over and over again. These are different means by which teachers and coaches can enhance the development of knowledge and decision-making in sport situations. This type of an approach can facilitate the achievement of the main goal of games education, which is to improve students as game players in order to increase competence, interest and enjoyment in games playing.

7.5 Methodological issues

Assessing game performance. Even though significant intra- and inter-observer correlation coefficients were found in all the variables, correlations were low in some cases. When evaluating the type and quality of the shots there was a problem with intra- and inter-observer reliability in two variables: shot execution and shot decision. It seems that shot execution was easier to define out of these two variables and that in both variables the consistency was better between repeated trials of one observer. As expected, the intra-observer reliability coefficient in shot decision was highest in the observer who was a badminton specialist. It appears that the definitions in both of the qualitative variables must be even more accurate and that it might be better to classify these variables into more than two qualitative categories.

The variability in the selected shots was highest in the drop shot (15.5%). One reason for this could be the video recorder´s slow motion function, which made observing the differences between the shots more difficult. Some differences were also found in the correlation coefficients of the positional variables and of the height of the shot. All of these factors can be partly explained by the camera view in this study, and can be improved by finding a more ideal shooting angle and height for the camera.

In the temporal variables the correlations were higher in the total playing time than in the effective playing time. This can be partly explained by the inaccuracy of the video recorder´s counter, which showed the time only within 1 second.

Assessing game understanding. There are several concerns to be discussed regarding the development and validation of this type of a test. One concern is the content of the test, meaning that the situations chosen for the test must always cover the basic tactical principles that the game poses at the specific performance level. Another caution relates to determining a suitable criterion for the groups. In experts, the criterion was based on the player´s tournament success, and it could have been improved by selecting a less ambiguous criterion, such as coaches´ assessment of players´ strategic abilities. On the other hand, in the case of novices, the only possible criterion would have been teacher´s observations of children's tactical abilities, but it would not have been adequate due to the low skill level of the children, and therefore, it was not established. Problems also existed in the group comparison, where the heterogeneity and the small number of participants in the expert group, as well as the unequal group sizes caused problems that had to be considered in the statistical analysis of this data. The marked differences found in the standard deviations between the groups are one indication of this problem. Several reasons, such as differences in age and thereby in game play and tournament and training experience, can be found to partly explain the heterogeneity of the expert group.

Expert-novice comparison. Even though this study was conducted using a design suggested by McPherson & Thomas (1989) and French & Thomas (1987), in which all the aspects that can contribute to expertise (skill, game performance and knowledge) were measured, certain critical points remain to be discussed. First, the skill test was found to be too difficult, especially for the novice players. Another type of test with larger target areas could have classified the novice players more properly. In addition, the test for the drop shot did not discriminate between novices and experts, and it was therefore excluded from the analysis. This could be due to difficulties in standardizing the hitting technique of the drop shot. Second, even though the experts for this study were selected by using two criteria; player´s actual rank and his/her selection to the FBA´s training groups, considerable variability was found especially in the scores of the video test. This indicates the difficulty of assembling a homogeneous and large enough expert group from a small number of candidates.

Intervention. As introduced by Rink et al. (1996b), there are many influencing factors in the research of games teaching. Some methodological points remain to be discussed in this study. It is obvious that the findings of this study are not applicable to other types of sports, such as invasion games, due to differences in the number of players and the tactical aspects of invasion games. Also, the age and experience level of the participants affects the findings, and therefore, these results mainly describe the qualities of developing adult players. The variables chosen for this investigation represent all the aspects that contribute to expertise in games, that is knowledge, game understanding, skill and game performance. Knowledge and the awareness of tactical aspects of the game developed faster than the skill execution components. Even though the length and type of intervention selected for this treatment period seemed to be long and effective enough for some changes to occur in all the measured variables of the treatment groups, significant improvements in the game performance variables were not detected. One of the reasons might be the inability of the observational tool to detect these differences in game play. Another reason might be the difficulty of standardizing the game performance measures. In other words, even though students were asked to choose an opponent of equal ability, the opponent´s style of play always affects game play. A larger number of played games or a longer treatment period may have enabled game performance variables to improve more significantly.

7.6 Recommendations for future research

Even though examining decision-making with regards to validity and reliability has been the main problem in this research area, the findings of this study support the assumption that valid and reliable tests for decision-making can be developed. In addition, the notational analysis system that we developed is a good addition to several computerized video analysis packages that exist to provide detailed qualitative and quantitative evaluation of game performance.

The results support the importance of tactical understanding in games. It is almost useless to master the skills of a game if a player does not know what, how and when to perform the specific skills. Even if it has been well documented that game understanding is as important as executing the skills, further knowledge regarding the transfer of knowledge and tactical understanding from performance in one game to performance in another, similar to the transfer of motor skills, would be an interesting subject in future research.

Game understanding is difficult to evaluate because all of its measures are indirect. When assessing a player´s game understanding by simulated badminton situations, we learn something about the player´s tactical knowledge but nothing about his/her ability to carry out the decisions in an actual game situation. It would nevertheless be crucial to know whether, what and how the tactical information transfers to the game situation. Therefore, there is a need for future research to develop objective and valid measures of transfer in order to assess learning.

Although the findings of this study suggest that a treatment period containing badminton knowledge, skills and movement techniques was effective enough to improve the knowledge base and skills of the treatment groups and that the video tasks significantly enhanced the development of tactical awareness, it still seems that many issues require further research. The optimal developmental and skill level of the participants for teaching decision-making skills, the structure of practice sessions and practice experiences that produce specific types of learning and the nature of instruction are still partly unanswered questions. Future studies should concentrate on finding out the possible effects of different types of instruction, feedback and simulations in order to facilitate the development of game understanding and game performance in a variety of games, from more simple ones (net games) to ones in a more complex environment (invasion games).

8 YHTEENVETO

Johdanto. Pelien pelaaminen ilman, että pelaaja tietää mitä ja milloin tehdään, on vaikeaa, ellei lähes mahdotonta. Erillisiä peliin liittyviä taitoja voidaan oppia irrallisina peliyhteydestä, mutta jos kyseiset taidot halutaan suorittaa pelitilanteessa, on pelaajan käytettävä ratkaisuntekotaitojaan päättäessään, mitä ja milloin hän tekee. Voidaankin väittää, että hyväksi pelaajaksi tuleminen vaatii hyvien fyysisten ja taidollisten ominaisuuksien lisäksi myös hyviä kognitiivisia taitoja. Thomasin (1994) mukaan urheilusuoritus (sport performance) voidaan tutkimustarkoituksessa jakaa kognitiiviseen ja taidolliseen osaan, joista kognitiivinen osa käsittää ratkaisunteon ja tiedot (decison-making and knowledge), kun taas taito-osa sisältää motorisen suorituksen (motor execution). Urheiluspesifi tutkimusmalli (Thomas ym., 1986), jota on sovellettu myös tässä tutkimuksessa, painottaakin molempien osa-alueiden tutkimista.

Tutkimuksen kohteeksi valittiin sulkapallo, joka on malliesimerkki pelistä, jossa pelaajan sekä kognitiiviset että taidolliset vaatimukset ovat korkeat. Sulkapallopelin aikana pelaajat tekevät satoja ratkaisuja ja ratkaisunteon on tapahduttava nopeasti ja tarkasti. Toisaalta sulkapallo ja sen viitepelit (esim. koppipallo) ovat mailapelien joukosta hyviä pelejä myös aloittelijoille, sillä välineenhallinta (kevyt maila ja hidas pallo) sekä sääntöjen ja perustaktiikan ymmärtäminen ovat suhteellisen helppoja.

Kansainvälisellä tasolla liikunnanopettajat ovat jo pitkään olleet kiinnostuneita siitä, miten pallopelejä tulisi parhaiten opettaa. Monien tutkijoiden mukaan (mm. Bunker & Thorpe, 1982, 1986; Griffin, Mitchell, & Oslin, 1997; Turner & Martinek, 1992) pelien opetuksessa tulisi keskittyä pelien taktisten tekijöiden opettamiseen aikaisemmin, jotta oppilaat säilyttäisivät mielenkiintonsa peleissä ja nauttisivat pelatessaan. Näiden ajatusten perusteella Bunker ja Thorpe (1982) esittelivät Englannissa mallin "Teaching Games for Understanding" (TGFU), joka keskittyi siihen, että pelaaja oppii tekemään taktisesti sopivan ratkaisun vaihtelevissa pelitilanteissa. Suomessa pelien opettaminen on keskittynyt pääasiassa taitojen opettamiseen. Näin pelikäsityksen kehittäminen ja ratkaisuntekoon liittyvät seikat ovat jääneet vähemmälle huomiolle. Tämän tutkimuksen tarkoituksena on esitellä uusia arviointimenetelmiä kognitiivisten ja motoristen taitojen tutkimiseen, soveltaa kehitettyjä menetelmiä eri ikä- ja taitotasoille sekä avata uusia näkökulmia palloilunopetukseen.

Tämä kolmivaiheinen tutkimus koostui neljästä erillisestä osatutkimuksesta. Kahdessa ensimmäisessä osatutkimuksessa käsiteltiin sulkapallon arviointimenetelmien kehittämistä sekä niiden pätevyyttä ja luotettavuutta (VAIHE 1). Kolmannessa osatutkimuksessa menetelmiä sovellettiin eri ikä- ja tasoryhmille (VAIHE 2) ja neljännessä osatutkimuksessa pyrittiin kehittämään liikunnanopiskelijoiden pelisuoritusta kuuden viikon interventiojakson aikana (VAIHE 3).

Neljän osatutkimuksen tavoitteet olivat tarkemmin seuraavat:

1. Kehittää validi ja reliaabeli menetelmä pelitaitojen arvioimiseen.
2. Kehittää validi ja reliaabeli menetelmä pelikäsityksen arvioimiseen.
3. Verrata eksperttien ja noviisien välisiä eroja pelikäsityksessä ja -taidoissa.
4. Tutkia kuuden viikon harjoitusjakson vaikutuksia liikunnanopiskelijoiden pelisuorituksiin.

Menetelmien kehittäminen. Pelitaitojen arvioimiseksi kehitettiin tietokonepohjainen pelianalyysiohjelma, jonka avulla pelianalyysin teko tapahtuu objektiivisesti ja luotettavasti. Pelianalyysiä varten ottelu kuvataan videonauhalle, jonka pohjalta peli analysoidaan jälkikäteen koodaten erikseen jokainen lyönti, sen lopputulos sekä pelaajien sijainti kentällä. Peliajan päivitys tapahtuu jokaisen pelipallon alkaessa ja päättyessä.

Pelianalyysin luotettavuutta tutkittiin siten, että kolme eri arvioitsijaa analysoi saman pelin kahdesti kirjallisten ohjeiden perusteella. Korkeimmat arvioitsijoiden sisäiset korrelaatiot havaittiin seuraavissa lyönneissä: syöttö, koholyönti ja iskulyönnin palautus (100 %) ja alhaisin pysäytyslyönnissä (87 %). Peliajan ja pelaajien sijaintiin liittyvien muuttujien osalta korkein arvioitsijoiden sisäinen ja välinen korrelaatio oli kokonaispeliajassa (r=.997 ja r=.997) ja alhaisin kuljetussa matkassa (r=.871 ja r=.813). Laadullisten muuttujien osalta korkeimmat arvioitsijoiden sisäiset ja väliset korrelaatiot havaittiin muuttujassa lyönnissä onnistuminen (r=1.000 ja r=1.00) ja alhaisimmat muuttujassa ratkaisunteon arvioiminen (r=.321 ja r=.134).

Pelikäsityksen arvioimiseksi kehitettiin kaksi videopohjaista pelikäsitystestiä: perustesti (B) ja kehittyneempi testi (A). Perustesti sisälsi 19 erilaista sulkapallon hyökkäys- ja puolustustilannetta. Tilanteet videolla rakentuivat seuraavasti: 4 - 7 sekuntia peliä, jonka jälkeen 10 sekunnin pysäytyskuva tilanteesta, missä pelaaja oli valmistautumassa lyöntisuoritukseen (kuva 11). Lopuksi kaaviokuva pelaajan lyöntivaihtoehdoista (kuva 12) oli näkyvissä 10 sekuntia. Tänä aikana pelaaja valitsi mielestään parhaimman ratkaisun sekä kaksi perustelua erillisestä 10 perustelua sisältävästä luettelosta kertoakseen, miksi hän valitsi tietyn vaihtoehdon. Perustestin pätevyyttä ja luotettavuutta tutkittiin peruskoulun ala-asteen oppilailla kahdessa eri ikäryhmässä (9 - 10 vuotta, n=61 ja 11 - 12 vuotta, n=59). Sisältövaliditeetin varmistamiseksi testitilanteiden valintaan käytettiin kahta asiantuntijaa, joiden mukaan testi oli sisällöltään pätevä mittaamaan pelikäsityksen perusteita sulkapallossa. Rakennevaliditeettia tutkittiin testin erottelukyvyllä. Testi erotteli eri ikäryhmät toisistaan, ja testin sisäinen pysyvyys määriteltiin testin 19 tilanteen osalta (α=.73).

Kehittyneempi testiversio sisälsi kaksi osaa (A3 ja A8), joissa kummassakin oli 15 sulkapallon hyökkäys- ja puolustuspelitilannetta. Tilanteet videolla rakentuivat seuraavasti: 2 - 7 sekuntia peliä, jonka jälkeen pysäytyskuva, johon oli piirretty nuolin kolme (A3, kuva 13) tai merkitty numeroin kahdeksan (A8, kuva 14) eri lyöntivaihtoehtoa, oli näkyvissä 10 s:n ajan. Pelaaja valitsi mielestään parhaimman lyöntivaihtoehdon ja sopivat perustelut valinnalleen 20 perustelun listasta. Kehittyneemmän testin pätevyyden ja luotettavuuden määrittämiseksi valittiin koehenkilöiksi sekä eksperttitason pelaajia (11 - 14 vuotta, n=19) että samanikäisiä noviiseja (n=45). Testin tilanteiden valintaan käytettiin kuutta eri asiantuntijaa, joiden mukaan testin sisältämät tilanteet edustivat pelin keskeisiä osa-alueita, mikä varmisti täten testin sisältövaliditeetin. Rakennevaliditeetin arvioinnin mukaan testin avulla pystyttiin erottaman eritasoiset pelaajat, ja kriteerivaliditeetti oli riittävällä tasolla A3-testin osalta. Testin luotettavuutta tutkittiin testin sisäisellä pysyvyydellä, joka 15 tilanteen osalta oli eksperttiryhmällä A3: α=.81 ja A8: α=.72. Testin toistettavuutta arvioitiin rinnakkais- ja uusintamittauksella. Testiosioiden välinen (A3 ja A8) korrelaatio oli r=.81, ja uusintamittausarvot eksperttiryhmällä olivat A3: r=.78 ja A8: r=.78.

Menetelmien soveltaminen. Kehitettyjä arviointimenetelmiä sovellettiin ensin peruskoululaisille kahdessa eri ikäryhmässä (9 vuotta, n= 10 ja 12 vuotta, n=10. Tarkoituksena oli tutkia aloittelijoiden pelikäsitystä sekä pelitaitoja sulkapallossa ja sen viitepelissä koppipallossa. Oppilaat osallistuivat pelikäsitystestiin (perustesti) ja pelasivat sulkapalloa ja koppipalloa 2 x 5 minuuttia eri vastustajia vastaan. Tulokset osoittivat, että ikäryhmät eivät eronneet merkitsevästi toisistaan pelikäsitystestin osalta ja vaikka oppilailla oli vain vähän kokemusta itse pelistä, perustaktiset asiat pystyttiin ymmärtämään. Sen sijaan pelianalyysimuuttujissa havaittiin eroja eri pelimuotojen ja ikäryhmien välillä. Kaiken kaikkiaan vanhempi ikäryhmä pelasi paremmin molempia pelejä. Vanhemmat oppilaat pelasivat sulkapalloa vähemmän kilpailullisesti kuin koppipalloa, missä he käyttivät monipuolisesti erilaisia heittoja ja myös hämäyksiä. Nuoremmat oppilaat eivät sulkapallossa yltäneet edes yhteistoiminnalliseen pelaamiseen vaan keskittyivät lähinnä palloon osumiseen ja sen saattamiseen verkon toiselle puolelle, kun taas koppipallossa pelaaminen onnistui paremmin.

Toiseksi arvioitiin eksperttien ja noviisien välisiä eroja pelikäsityksessä sekä lyönti- ja pelitaidoissa. Ekspertteinä toimivat Suomen Sulkapalloliiton valmennusryhmään kuuluvat (13 - 14 vuotta, n=12) ikäluokkansa huippu-pelaajat ja noviiseina samanikäiset koululaiset (n=14), joilla ei ollut aiempaa pelikokemusta. Testien perusteella havaittiin eroja kaikissa mitatuissa muuttujissa. Ekspertit olivat taitavampia, pelasivat tehokkaammin ja ymmärsivät paremmin pelitilanteita noviiseihin verrattuna. Pelianalyysin perusteella voidaan sanoa, että noviisien peli oli virheettömämpää kuin eksperttien peli, joka taas puolestaan oli tehokkaampaa. Nämä seikat ovat osoituksena eroista pelityyleissä: noviisit pelasivat lyöden hiljaisia lyöntejä kohti vastustajaa, kun taas ekspertit pyrkivät liikuttamaan vastustajaansa ympäri kenttää tarkoilla lyönneillä, jolloin myös virheiden mahdollisuus pelissä kasvoi. Eksperttien kyky valita paremmat ratkaisut ja perustella ne ovat osoituksena heidän paremmin rakentuneesta deklaratiivisesta ja proseduraalisesta tiedostaan, joka kehittyy kokemuksen ja harjoittelun myötä. Toisaalta noviisit ovat kykenemättömiä valitsemaan oikeita ratkaisuja, koska heidän proseduraalinen tietonsa ei ollut kehittynyt.

Kolmanneksi tutkittiin kahden erityyppisen opetusjakson vaikutuksia liikunnanopiskelijoiden sulkapallon pelaamiseen. Tutkimuksessa oli kaksi koeryhmää (n=11, koeryhmä 1 ja n=10, koeryhmä 2) ja kontrolliryhmä (n=9). Molemmat koeryhmät osallistuivat sulkapallokurssille, jonka kesto oli 20 tuntia. Kurssi sisälsi sekä tietoja sulkapallopelistä ja sen säännöistä että käytännön harjoitteita, jotka liittyivät lyönti- ja liikkumistekniikkoihin. Kurssin jälkeen molemmat koeryhmät pelasivat sulkapalloa kaksi kertaa viikossa 45 minuutin ajan ja lisäksi koeryhmä 1 sai videopohjaista taktiikkaopetusta kaksi kertaa viikossa. Kaikki koehenkilöt (n=30) testattiin ennen ja jälkeen opetusjakson sulkapallotietojen, pelikäsityksen sekä lyönti- ja pelitaitojen osalta. Opetusjakson jälkeisten tulosten perusteella havaittiin, että koeryhmä 1, joka sai erillistä videopohjaista taktiikkaopetusta, paransi eniten sulkapallon tietotestistä ja myös pelikäsitystestin perusteluista saatuja pistemääriä. Taitotestin ja pelianalyysin tulosten perusteella merkitsevää kehitystä koeryhmillä havaittiin ainoastaan syöttötaidossa, vaikka useissa pelianalyysimuuttujissa havaittiinkin selkeä koeryhmiä suosiva suuntaus.

Pohdinta ja johtopäätökset. Tutkimus vahvistaa käsitystä, että ratkaisunteko on tärkeää oppia erityisesti taktisesti vaativissa lajeissa (Thomas, 1994), kuten sulkapallossa. Oppilaiden ja pelaajien tulee ymmärtää, että tehokas pelisuoritus riippuu oikeista pelitilanneratkaisuista, ja tämän vuoksi pelikäsityksen kehittämisen tulisi olla yksi pelien opettamisen ja valmentamisen päätavoitteista. Vaikka Rink, French ja Graham (1996a) ovat esittäneet, että pelin yleinen taktinen tietoisuus kehittyy peliä pelaamalla, voidaan kuitenkin olettaa, että kun kysymyksessä ovat monimutkaisemmat taktiset ratkaisut, niissä kehittyminen vaatii opettamista. Kysymyksiin milloin ja miten ratkaisuntekoa olisi parasta opettaa, ei tämäkään tutkimus anna suoranaista vastausta. Tutkimuksessa saatiin kuitenkin viitteitä siitä, että jo 9-vuotiaat ymmärtävät pelin taktisia perusideoita. Edelleen pelkästään iän lisääntyminen ei näytä merkitsevästi kehittävän pelikäsitystä, vaan siihen vaaditaan lajikohtaista kokemusta.

Myös pelikäsityksen kuten muidenkin ominaisuuksien opettamisessa opettajien ja valmentajien tulisi tunnistaa oppilaiden tai pelaajien kehitystaso, jotta pystytään tarjoamaan sopivan tasoisia ja haastavia tehtäviä. Aloittelijoiden tasolla perustaktiset ongelmat ratkaistaan pääasiassa lyöntivalinnan ja kenttäsijainnin perusteella. Oppilaiden tulee keskittyä lyhyen ja pitkän pelin käsitteisiin sekä niihin liittyviin taktisiin ongelmiin ja taitoihin (miten teen tyhjää tilaa, miten puolustan tyhjää tilaa, miten lyön pallon taakse tai eteen). Bunker ja Thorpe (1982) ovat esittäneet pelien opetukseen soveltuvan taktisen opetusmallin, missä lasten kehitystaso otetaan alusta asti huomioon. Tämän lähestymistavan mukaan valittua pelimuotoa käytetään taktisten ongelmien esilletuomiseen ja ratkaisunteon opettamiseen. Kuten tässäkin tutkimuksessa tuli ilmi, ala-asteikäisillä oppilailla pelikäsitys sulkapallossa oli jo osittain kehittynyt. Kuitenkin itse pelissä sitä pystyttiin toteuttamaan vain koppi-pallossa, missä taitovaatimukset eivät rajoittaneet oppilaiden pelikäsityksen soveltamista pelissä.

Vaikka tämän tutkimuksen pääasiallisena tavoitteena oli pätevien ja luotettavien arviointimenetelmien kehittäminen pelikäsityksen ja -taitojen arvioimiseksi, se antaa välillisesti keinoja opettajille ja valmentajille myös pelitaitojen analysointiin ja erityisesti pelikäsityksen kehittämiseen. Pelianalyysin avulla voidaan oppilaita (esim. liikunnanopettajaopiskelijat) ohjata havaitsemaan ja arvioimaan pelin eri osa-alueita (tekniikka, taktiikka, liikkuminen, aika-analyysi) objektiivisesti ja luotettavasti. Lisäksi menetelmä on hyvä apuväline oman pelin reflektiivisessä arvioinnissa. Yksinkertaisemmassa muodossa pelistä tehtävä analyysi on käyttökelpoinen arviointimenetelmä myös liikuntatunneilla jopa oppilaiden itsensä tekemänä. Pelikäsitysvideon tai videopohjaisten tehtävien pohjalta voidaan taas toisaalta käydä läpi erilaisia ratkaisuvaihtoehtoja vaihtelevissa pelitilanteissa. Ratkaisuista sekä niihin liittyvistä perusteluista voidaan keskustella joko ryhmässä tai opettajan/ valmentajan kanssa. Opettajan tai valmentajan roolina näissä tilanteissa on esittää sopivia kysymyksiä oppilaiden kriittisen ajattelun ja ongelmanratkaisukyvyn kehittämiseksi. Näin monipuolisten, eri näkökulmia kattavien ja toistuvien tilannetehtävien kautta oppilaat tai pelaajat oppivat vähitellen tunnistamaan erilaisia pelitilanteita, suunnittelemaan toimiaan etukäteen tai valitsemaan parhaimman ratkaisun vaihtelevissa pelitilanteissa.

Tulevaisuudessa monet kehitysvaiheeseen, opettamiseen, palautteeseen ja simulointiin liittyvät tekijät, joilla osaltaan voidaan edistää pelikäsityksen kehittymistä, vaativat vielä lisätutkimusta.

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