EXAMINATION OF EXPERT AND NOVICE VOLLEYBALL COACHES'

DIAGNOSTIC ABILITY

by

WEI BIAN

(Under the Direction of PAUL G. SCHEMPP)

ABSTRACT

The purpose of this study was to examine expert and novice volleyball coaches' diagnostic ability of a volleyball skill. Specifically, this study investigated the differences between expert and novice volleyball coaches in a) knowledge base of the volleyball spike, b) information cue acquisition and interpretation, c) linkage between knowledge structure and diagnostic performance, and d) the diagnostic decisions regarding coaches' corrective recommendations for performance improvement. Four expert and four novice Iowa high school volleyball coaches participated in this study. Research procedures included an interview regarding an ideal volleyball spike, a recall test on slides of volleyball spiking images, and a diagnostic task where the coaches analyzed the volleyball spike performance.

Data analysis revealed differences of coaches' diagnostic ability between expert and novice volleyball coaches. Expert coaches' knowledge regarding the volleyball spike was richer and more extensive than that of novices in a) the number of the components identified, b) the number of body parts used to describe the skill, and c) in the judgment as to which issues are most critical in skill execution. Expert coaches' explanations about an ideal spike demonstrated the knowledge that was more technically specific, and procedure-oriented, which may have been enhanced by their years of successful coaching experience.

Interpretation of acquired cues differed between expert and novice coaches in this study. Expert coaches' recall statements were more evaluative and technique-related. Novice coaches, on the other hand, were more descriptive and game-situation oriented. Although both expert and novice coaches perceived a similar number of information cues during the skill diagnosis, experts perceived a greater number of information cues in technique deficiencies as compared to the novices, specifically in the approach and the jump phases.

The results revealed connections between coaches' knowledge of the volleyball spike and their diagnostic performance. It appeared that coaches' diagnostic ability depends on the schemas pertaining to an ideal volleyball technique and its critical features. Expert coaches' recommendations for skill improvement were based on more extensive analysis and reasoning. Their suggestions were more sequential and processbased than the novice coaches.

INDEX WORDS: Diagnostic ability, Expert, Novice, Coaching, Volleyball, Schemas, Knowledge, Information cues

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DEDICATION

To my late father, Yin-nan Bian and my late uncle, Richard (Peng-nian) Bien

You are my inspiration in my life.

Go the Distance

Lyrics from the Disney Movie "Hercules"

I have often dreamed Of a far off place Where a hero's welcome Would be waiting for me Where the crowds will cheer When they see my face And a voice keeps saying This is where I'm meant to be

I'll be there someday I can go the distance I will find my way If I can be strong I know every mile Will be worth my while When I go the distance I'll be right where I belong Down an unknown road To embrace my fate Though that road may wander It will lead me to you And a thousand years Would be worth the wait It might take a lifetime But somehow I'll see it through

And I won't be looking back I can go the distance And I'll stay on track No I won't accept defeat It's an uphill slope But I won't lose hope Till I go the distance And my journey is complete

But to look beyond the glory is the hardest part For a hero's strength is measured by his heart Like a shooting star I will go the distance I will search the world I will face its harms I don't care how far I can go the distance Till I find my hero's welcome Waiting in your arms...

Although the road to the academic success is not easy, I will go the distance.

Wei 7-22-2003

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CHAPTER 1

INTRODUCTION

For millions of athletes around the world, an Olympic gold medal is their ultimate goal for athletic achievement. For millions of coaches behind them, developing and improving athletes' performance for their best potential is the ultimate measure of coaches' success. Often, those who consistently perform at greater levels and reach higher standards of efficiency in coaching are recognized as the expert coaches. They are an elite group of people who have demonstrated many unique characteristics and have made a great impact on both the athletes and the sport they have coached.

By definition, expertise can be considered as the possession of a large body of knowledge and procedural skills. For more than thirty years, cognitive scientists considered research on expertise as an important testing ground for theories of cognition. This has led to a rapid increase of the research to examine the differences between experts and novices in many domains such as chess players (De Groot, 1978; Chase & Simon, 1973), physicists, (Chi, Feltovich, & Glaser, 1981), waiters (Ericsson & Polson, 1988), athletes (Starkes & Deakin, 1984) and computer programmers (Soloway, Adelson, & Ehrlich, 1988). These studies provided insight into the cognitive processes of the knowledge base, memory, perception, and decision-making process that underline differences in expert and novice performance. Furthermore, they have established a theoretical framework to pave the way for future exploration in many other specific fields. Research on coaching expertise has examined both coaches' behavior and coaches' cognitive process (Abraham & Collins, 1998). Evidence obtained from these studies has shown that expert coaches can make extensive use of their knowledge of a subject matter (Johnson, 1988). Expert coaches demonstrate a superior knowledge base, longer reasoning chains, as well as a holistic and unified understanding of the movement when performing motor skill diagnostic tasks (Leas & Chi, 1993). Their enhanced selective-attention process and better-refined perceptual strategies for information cue interpretation enable them to distinguish their superior performance from those of novices (Leas & Chi, 1993; Williams & Davids, 1998). As Paull and Glencross (1997) indicated: "Expert perception is not a function of the visual hardware, but rather a consequence of the software of knowledge structures which enhances perception" (p.38).

In sports, coaches can serve two important roles for the players' skill acquisition and development. First, they serve as an expert to help players build their knowledge base of a particular sport. Second, they play a role as a feedback mechanism to guide players in honing their techniques for better performance (Charness, Krampe, & Mayr, 1996). To do so, coaches must be good at motor skill diagnosis. They not only need to have sharp "eyes" to detect what is wrong, but they also must know how to correct errors and communicate this knowledge to the athlete. Expert golf coaches view themselves as repair people who diagnose problems and attempt to "correct deficiencies and errors in the skill performance of their students" (McCullick, 1999, p. 23). Therefore, being able to accurately describe and evaluate a motor skill is essential for providing beneficial feedback to refine and improve the technique for better performance. The ability to diagnose motor skills is, therefore, an important competency in sport coaching and physical education instruction (e.g., Langley & Woods, 1997; Vickers, 1990).

Studies using an expert/novice paradigm provided evidence that expert coaches analyze a movement qualitatively better than novices do (Leas & Chi, 1993; Woorons, 2001). Experts differ from novices in diagnosing movement skills. They were able to "detect errors and appropriate aspects of skill performance" (Dodds, 1994, p. 154). Their knowledge organization provided them with acute perceptual capacities to facilitate movement diagnosis. In addition, expert coaches perceive a motor skill analytically and demonstrated greater analysis of motor skills than novices (Woorons, 2001). Experts not only search for different information, but also have different searching patterns, which are more active and flexible than that of novices.

Similar to disease diagnosis in the medical field, the process of motor skill assessment can be called clinical diagnosis in sport. Leas and Chi (1993) defined this process as the "act of directly observing an athlete's performance for the purpose of analyzing the technique to identify the possible errors or weaknesses and to recommend remedial action" (Leas & Chi, 1993, p. 77). According to Pinheiro and Simon's (1992) model, a motor skill diagnostic process involves three steps. First, the coach acquires information cues that can trigger recognition processes. The recognition of which information cues depend on the coaches' systematic observation of the motor skill, especially on the comparison between the actual performance and the ideal model stored in the coaches' memory. The second step is cue interpretation, in which coaches attempt to find possible meanings for recognized cues. In this stage, prerequisite knowledge learned and stored in long-term memory is critical for interpretation accuracy. The last step of this skill diagnosis model is making judgments of the detected errors and providing corrective comments for skill improvement. One can view this process as skill information cue selection, information cue interpretation, and information transition for remedy.

Although motor skill diagnosis is widely recognized to be critical for coaches and physical educators, research pertaining to this topic is relatively scarce (Leas and Chi, 1993; Pinheiro & Simon, 1992). "The domain of sport-specific knowledge is even more sparse in the literature rather than that of coaching knowledge. The few studies that were completed have concentrated on assessing coaches' or teachers' knowledge of technique" (Abraham & Collins, 1998, p.69). Research on the difference between diagnostic knowledge ability of expert and novice coaches in the domain of volleyball is especially inadequate. "The most common ways to consider the role of information processing in the development of expertise is to determine the amount of expert-novice difference or expert-expert difference that a component explains" (Thomas, 1994, p. 205). Therefore, gaining entrance to the cognitive process of expert volleyball coaches' diagnostic ability should help coaches and sport instructors understand what expert coaches know and how they use that knowledge to improve athletic performance. Information from research on the diagnostic processes of coaches has the potential for practical applications to technique training, motor skill assessment and improvement for sport coaches and physical educators. Additionally, it will help novice coaches and pre-service physical educators to develop instructional strategies and motor skill diagnostic competence.

Research Questions

The purpose of this study was, therefore, to examine expert and novice volleyball coaches' diagnostic ability. This study was designed to address the following questions: 1. How does expert volleyball coaches' knowledge of the volleyball spike differ from that of novice coaches'?

2. What are the differences in information cue acquisition and interpretation between expert and novice volleyball coaches?

3. How do knowledge structures contribute to diagnostic differences between expert and novice coaches?

4. What are the differences between expert and novice diagnostic decisions regarding their corrective suggestions for performance improvement?

Definition of Terms

Expertise

By definition, expertise is referred to as the possession of a large body of knowledge and procedural skills. The ways in which experts use that body of knowledge and employ certain theoretical frameworks has been found to differ from the ways novices' process responses to problematic situation.

Knowledge Base

Traditionally, a knowledge base has been conceptualized as prepositional networks of declarative knowledge or as procedural knowledge in the form of productions or condition-action procedures (French & McPherson, 1999).

Diagnostic Ability

Diagnostic ability of a motor skill can be defined as "the ability to recognize variations from a schema in visually presented examples of a motor skill. To make a diagnosis is to compare the problematic technique profile with a standard profile in long-term memory, drawn from all the information available as a result of experience and learning" (Pinheiro & Simon, 1992, p.292). It is "the act of directly observing an athlete's performance for the purpose of analyzing the technique to identify the possible errors or weaknesses and to recommend remedial action" (Leas & Chi, 1993, p. 77).

<u>Schemas</u>

Schemas are "generic knowledge structures that guide the comprehender's interpretations, inferences, expectations, and attention when passages are comprehended" (Soloway, Adelson, & Ehrlich, 1988, p. 130).

CHAPTER 2

REVIEW OF RELATED LITERATURE

The purpose of this study was to examine volleyball expert and novice coaches' diagnostic ability of a volleyball skill. This study was designed to provide information on the following questions: (1) How does expert volleyball coaches' knowledge of the volleyball spike differ from that of novice coaches? (2) What are the differences in information cues acquisition and interpretation between expert and novice volleyball coaches? (3) How do knowledge structures contribute to diagnostic differences between expert and novice coaches? (4) What are the differences between expert and novice diagnostic decisions regarding their corrective suggestions for performance improvement?

This chapter provides a literature review pertaining to the studies on diagnostic ability, expertise in teaching and coaching as well as research in other domains. It was reviewed in six sections including (a) cognitive psychology theoretical framework, (b) experts' diagnostic abilities, (c) experts' knowledge, (d) experts' perceptions, (e) experts' decision-making process, and (f) characteristics of expertise.

Cognitive Psychology Theoretical Framework

For more than thirty years, cognitive scientists considered research on expertise as an important testing ground for theories of cognition. This rapidly increasing body of research has examined the differences between experts and novices in various domains such as chess players (de Groot, 1978; Chase & Simon, 1973), physicists, (Chi, Feltovich, & Glaser, 1981), waiter (Ericson & Polson, 1988), athletes (Starkes & Deakin, 1984) and computer programmers (Soloway, Adelson, & Ehrlich, 1988). These studies provided insight into the cognitive processes of the knowledge base, memory, perception, and decision-making process that underlie differences in expert and novice performance. Furthermore, they have established a theoretical framework to pave the way for future exploration in many other specific fields.

Classical Studies of the Chess Players

In a pioneering work on expertise study, de Groot (1978) applied think-aloud protocols to study chess player decisions of their next move under different chess positions. The chess players from different performing level (i.e. the grand masters, masters, and less skilled chess players) were presented with a number of unfamiliar positions. They were asked to select the best move within a short period of time and provide their verbal report of their decision-making process. Results showed that the grand masters were able to perceive and recognize the characteristics of a chess position better than other chess players. Their decisions when selecting the best move relied on their extensive experience rather than on calculating the move possibilities. Although the master-level chess players had a limitation of short-term memory as did all other levels of chess player, their expansive and effective long-term memories enabled them to demonstrate superior performance by applying chunk encoding and structural perception.

Chase and Simon's study (1973) on chess masters' memory performance was a classic work that paved the road for the research on expertise. Results showed that expert chess players were able to recall more corrective chess piece locations than novices on representative chess positions. The researchers concluded that expert chess players could

encode the information in larger perceptual structures, which were called chunks. Such differences between experts and novices may be explained by a hierarchical organization of the chunks related to chess skill and superior memory to many chess real game situations.

In a review of motor expertise research, Abernethy and his colleagues (1993) summarized de Groot, and Chase and Simon's studies as follows:

The pattern recognition paradigm of de Groot and Chase and Simon (1973) is used to highlight the differential recall and recognition performance of experts and novices for perceptual material varying in its degree of task structure. Experts are typically shown to be able to recall more stimulus items than novices when the stimulus display contains structure with which they are familiar but to perform equal to novices when the characteristic patterns or structures within the display are removed...experts improve their recall of structured material by using pattern information to increase size of the chunks of information stored in memory (p. 323).

Skilled Memory Theory Applied to Study the Expert Waiter

Skilled memory is a theoretical framework that indicated subjects could make efficient use of long-term memory to improve their memory capacity. According to skilled memory theory, subjects first use existing knowledge and patterns to encode present information. Then, they divided the information into units or chunks. Since the number of units was limited due to the attention capacity, the subjects will access the knowledge through recognition of retrieval cues stored in long-term memory. "Subjects generate long-term memory encoding of the presented information using existing knowledge, rather than accessing preexisting chunks or patterns" (Ericsson & Polson, 1988, p. 24). Such an encoding ability could be improved through the practice that is specific to the stimulus domain (Chase and Ericsson1981, 1982).

To test skilled memory theory, Ericsson and Polson (1988) designed a lab situation that represented ordering food in a real restaurant. The study compared JC, a master waiter, with other untrained subjects by examining the order recall strategy, the mean study time per table size, and the mean number of recall errors per table size and so on. Results of JC's exceptional memory skill supported Chase and Ericsson (1981)'s skilled memory theory that "subjects are able to extend their limited short-term memory by using long-term memory with rapid and accurate encoding and retrieval in such a way that the performance characteristics resemble the use of short-term memory by untrained subjects" (Ericsson & Polson, 1988, p. 41).

Study of Problem Categorization and Representation of Expert and Novice Physicists

In 1981, Chi, Feltovich, & Glaser conducted a series of studies to examine the differences in problem categorization and representation between expert and novice physicists. Results of problem similarity sorting task suggested that both experts and novices were able to categorize problems in a meaningful way. "Experts are able to 'see' the underlying similarities in a great number of problems, whereas the novices 'see' a variety of problems that they consider to be dissimilar because the surface features are different" (Chi, Feltovich, & Glaser, 1981, p. 130). The research concluded that experts categorize problems by law of physics, while novices tend to group the problems by surface features.

In order to examine the assumption that experts and novices problem schemata contain "different" knowledge, the researchers also compared the "basic approach" that experts and novices used for problem solving. Findings revealed that experts perceived more in a problem statement than did novices. "They have a great deal of tacit knowledge that can be used to make inference and derivations from the situation described by the problem statement" (p.149).

Huber (1997) summarized Chi and her colleagues' (1981) study on expert and novice physicists and suggested the following distinctive findings: (a) experts differ from novices in mental structure or organization, engaging in problem solving with a scientific, higher order representation, (b) experts have more central concepts with a complex network in memory relevant to their subject domain, (c) experts have more interrelations of concept connections, (d) experts have more robust relations between concepts that allow them to evoke a greater number of other concepts, and (e) experts associate more procedural knowledge with a problem than do novices.

Schemas and Characteristics of Schemas

By definition, schemas are the "generic knowledge structures that guide the comprehender's interpretations, inferences, expectations, and attention when passages are comprehended" (Soloway, Adelson, & Ehrlich, 1988, p. 130). Marshall (1995) also defined schemas as a vehicle of memory, that allowing organization of an individual's similar experiences in such a way that the individual can easily recognize additional experiences that are also similar, discriminating between these and ones that are dissimilar. A schema can access a generic framework that contains the essential elements of all of these similar experiences, including verbal and nonverbal components. It can

draw inferences, make estimates, create goals, and develop plans using the framework (Marshall, 1995, p. 39).

Marshall (1995) identified several characteristics of schemas. They are:

- 1. Schemas are stored in human memory.
- 2. Schemas have a network (chunk) so that it reduces the searching time, retrieval time and strains on short term memory (since a schema represents efficient chunking).
- 3. Schemas from the same subject domain are connected to each other. Components within a single schema have many connections, so it holds together.
- Flexibility is one of the most interesting characteristics of a schema. In most cases, the schema in memory will contain a great deal more information that can be used in one particular instantiation.
- 5. Schemas vary in size. A schema can be large or small. Some are very broad and some are highly specific.
- 6. Schemas may be embed and overlap.

According to Marshall (1995)'s schemas theory in problem solving, "A schema is a goal-oriented cognitive mechanism. The goal is to solve the problem" (p. 54). "Schemas develop after many similar and repeated experiences, each of which constitutes a problem for the individual. Schemas are used to interpret the problem and to apply to it as much as possible any relevant prior knowledge, using both parallel and sequential cognitive processing" (p. 58).

Expert and Novice Paradigm in Studying of Expertise in Cognitive Psychology

Examples of classic studies of expertise in cognitive psychology applied a method that compares experts and novices performance in a specific domain. This expert and

novice paradigm assumes the existence of experts and novices. Experts who had more experience were distinct from novices when examining the differences and similarities of expert and novice performance on a particular task. Previous studies revealed many unique characteristics of expertise when comparing the performance difference between experts and novices (e.g. Chi, Feltovich, & Glaser, 1981; Leas & Chi, 1993; Sabers, Cushing, & Berliner, 1991; Schenk, Vitalari & Davis, 1998). It was shown that the expert-novice paradigm is one of the popular models used for research on expertise (Woorons, 2002).

In summary, research on expertise applied the expert/novice paradigm to examine the differences between experts and novices in many domains. These pioneering and classical studies have demonstrated that experts could encode the information in larger perceptual structures, which were called chunks. Experts were better able to access their long-term memory with a more rapid and accurate encoding in order to extend their limited short-term memory than were untrained subjects. Experts associate more procedural knowledge with a problem than do novices. Therefore, previous studies of cognitive psychology have established a solid theoretical framework and paved the road for future researchers to explore expertise in many other fields.

Expert Diagnostic Abilities

Diagnostic Ability

Diagnostic ability is the ability of a sport coach or an instructor to effectively diagnose weaknesses and strengths of movement performance and to prescribe a remedy for improvement. It is recognized as one of the most important skills in developing coaching and teaching expertise. The diagnosing process is started from performance observation and skill analysis, followed by possible errors or weaknesses identification and concluded with remedial recommendation for improvement. It is the ability that enables coaches "to recognize variations from a schema in visually presented examples of a motor skill. To make a diagnosis is to compare the problematic technique profile with a standard profile in long-term memory, drawn from all the information available as a result of experience and learning" (Pinheiro & Simon, 1992, p.292).

Difference of Diagnostic Ability between Expert and Novice Coaches and Sport Instructors

Leas and Chi (1993) studied swimming coaches' diagnostic knowledge of the competitive freestyle swimming stroke to capture experts and novices conceptual and procedural knowledge. The researchers compared the similarities and differences between the two groups in the amount of knowledge, the connections of the knowledge, and the types of knowledge. Results indicated that expert swimming coaches demonstrated a superior knowledge base when being asked to describe an ideal swimming technique. Their swimming stroke skill diagnosis performance demonstrated that expert coaches used more holistic and process-based diagnosis with more connected knowledge. Their diagnosis on swimming stroke was more accurate than that of the novices. "Experts utilized more of the specific stroke features which incorporate hydrodynamic and biomechanics parameters. In contrast, the novices' prototype highlighted their use of mostly vague descriptions" (Leas & Chi, 1993, p. 90).

Expert sport instructors are "qualitatively different from novices in their ability to detect errors and appropriate aspects of skill performance...Experts differ from novices in diagnosing movement skills" (Dodds, 1994, p. 157). Experts' knowledge organization

facilitated movement diagnosis and provided them with acute perceptual capacities. Pinheiro's (1987, 1989) study of expert and novice track and field coaches' diagnostic ability on the shot put technique showed significant differences between experts and novices. Results revealed that expert coaches made more cue interpretations and diagnostic decisions than did novices. Novice coaches, meanwhile, failed to identify some important technical errors and their diagnostic performance was more superficial than the expert coaches.

Motor Skill Diagnosis Models

Based on an informational processing approach, Pinheiro and Simon (1992) proposed a model that described the overall process of motor skill diagnosis. According to their model, there are three steps in the process of motor skill diagnosis. First, the coach acquires information cues that can trigger recognition processes. The recognition of what kind of information cues depends on the coach's systematic observation of the motor skill, especially on the comparison between the actual performance and the ideal model stored in coach's memory. The second step is cue interpretation in which the coach attempts to find possible meanings for recognized cues. In this stage, prerequisite knowledge learned and stored in long-term memory is critical for interpretation accuracy. Furthermore, the interpretation accuracy determines which skill errors will be detected and which ones will be missed during the diagnosis. The last step of this skill diagnosis model involves making judgments regarding the detected errors and providing corrective comments for skill improvement. The coach's judgment or opinion about the performance depends on the evidence collected during the first two stages of the diagnostic process. It was noted that experts intended to focus their attention on the cues

they consider significant and to ignore those judged unimportant in recognition process. The framework of the model shows that the accuracy of diagnosis depends on the cues obtained from the performance. Therefore, perceptual ability—the ability to notice and interpret relevant cues—is essential to carry out the intended diagnostic task (Pinheiro & Simon, 1992).

Knudson and Morrison (2002) proposed a comprehensive model that blended several sub-disciplines (pedagogy, biomechanics, motor development and learning, sport psychology) for qualitatively analyzing human movement. They define qualitative analysis as "the systematic observation and introspective judgement of the quality of human movement for the purpose of providing the most appropriate intervention to improve performance" (p. 4). The first step of an integrated qualitative analysis is to gather relevant knowledge to prepare for the analysis. It involves building a knowledge base pertaining to the movement to be analyzed. Knowledge about the activity or movement, knowledge about the performer(s), and knowledge about effective instruction are three major areas for information prerequisition.

Coaches and sport instructors need to be familiar with the terminology, critical features, and common errors of the movement. In addition, they have to be knowledgeable about performer(s) for selecting proper feedback and methods to coach and teach effectively. The second task is observation. The authors pointed out that "good observation of human movement is based on a systematic observational strategy to gather information about the critical features of a movement" (Knudson & Morrison, 2002, p. 108). Individual's knowledge base, attention, observation view distance and angles, and the usage of all senses are among some important points that could contribute to

observational task. Evaluation and diagnosis is the third task in Knudson and Morrison (2002)'s qualitative analysis model. It is a process that the analyst makes the judgement of the performance's strengths and identifies errors and mistakes to prioritize intervention for maximizing improvement. Once the strengths and weaknesses of the performance have been evaluated and diagnosed, the last task of the model is to provide feedback, corrections and suggestions as the step of intervention. Every step in this model is important. "Neglect of any one of the four tasks limits a teacher's or coach's effectiveness in improving players' performances" (p. 11). The purpose of developing this qualitative analysis model is to enlarge the vision of qualitative analysis in order to gather information about the strengths and weaknesses of the movement.

Knudson and Morrison (2002) also discussed Pinheiro and Simon's model in their book. They attempted to relate Pinheiro and Simon's (1992) information processing steps to the tasks of their qualitative analysis model. They indicated:

Cue acquisition is like the observation task in our integrated, comprehensive model of qualitative analysis. Cue interpretation is analogous to our evaluation step. And the diagnostic decision is analogous to the diagnosis step within the evaluation and diagnosis task of qualitative analysis. All of these processes can also be viewed as part of information processing in qualitative analysis (p. 31).

Study of Radiologist Diagnostic Ability

Lesgold and his colleagues' study (1981) of expert and novice radiologists can be considered as one of the classical research investigation related to diagnostic ability and expertise. Participants were asked to observe X-ray films related to lung disease and then report what they viewed through a diagnostic record. Data analysis compared the differences in diagnosis processes between experts and two other less experienced groups. Results showed that the expert group exceeded the other groups on many measures such as having more different findings, and longer reasoning chains. Experts were more schema driven in their diagnosis and had more refined schema that allowed them to make better discriminations. Experts "see things differently". They know where to look for signs that could trigger the interpretation for abnormalities of the lung disease. They also have a better, fine-tuned visual acuity than novices. Findings of this study support the view that experts were doing more inferential thinking while novices were more superficial, fragmented, and piecemeal. "The acquisition of expertise consists in ever more refined versions of schemata developing though a cognitively deep form of generalization and discrimination" (Lesgold et al, 1988, p. 340).

Expert Coaches Perception of Diagnostic Ability

McCullick (1999) examined expert golf coaches' orientations toward teaching and coaching. The questionnaire survey investigated 100 top golf instructors on their knowledge, experiences, and orientations. Results showed expert coaches view student improvement and learning as the indicators of instructional achievement. They considered the analytic and diagnostic skills as essential pedagogical tools to enhance learning. Expert coaches view themselves as repair people whose role is to diagnose problems and attempt to "correct deficiencies and errors in the skill performance of their students" (McCullick, 1999, p. 23).

In this session, two motor skill diagnostic models (Knudson & Morrison, 2002; Pinheiro & Simon, 1992) were introduced and discussed. Studies related to examine the expert/novice diagnostic ability showed that experts had more refined schema and a superior knowledge base. Their diagnostic decisions were more holistic and processbased (Leas & Chi, 1993). Experts were more schema driven in their diagnosis and had more refined schemas that allowed them to make better discriminations. Experts' automatic-recognition capability enabled them to have more accurate cue interpretations (Lesgold, et al, 1981).

Experts' Knowledge

Research on expertise utilized knowledge-based approaches to study the difference between experts and novices in what they know and how they apply that knowledge (Chi, 1981; Leas & Chi, 1993). Studies adapted a variety of methods such as questionnaires, structured interviews, and think-aloud protocols to capture experts' cognitive processes for insightful understanding of expertise in many domains. Declarative and Procedural Knowledge

There are two types of knowledge: declarative knowledge and procedural knowledge. Declarative knowledge is the knowledge of facts relevant to a specific task. It is related to "what the fact is". Procedural knowledge, on the other hand, refers to a domain specific knowledge about "how to do" something (Abernethy, Thomas, & Thomas, 1993).

In a study of motor expertise, procedural knowledge of motor skill can refer to movement selection and execution. Abernethy et al (1993) noted that for high strategy motor skill, procedural knowledge could be related to movement selection such as knowledge of where the opponent moves, and who is the weakest person on the other side. The procedural knowledge for low strategy motor skill can be entirely related to skill execution (e.g., step, turn, accelerate, jump, etc). They pointed out: In the early stages of learning, skill execution is probably the primary focus of procedural knowledge development, but as the execution of the action becomes more automatic, strategies pertaining to response selection may become the primary site for procedural knowledge development (Abernethy, et al, 1993, p.324).

Gilhooly and Green (1988, p. 379) define expertise as "...possession of a large body of knowledge and procedural skill". Experts in the motor skill domain have been shown to possess a more complete declarative and procedural knowledge than novices (French & Thomas, 1987; McPherson & Thomas, 1989). Experts have been consistently reported to be able to see and represent problems at a deeper level by using principles and concepts. Novices, on the other hand, rely on more superficial features when solving the problems.

Experts' Knowledge Organization

Knowledge organization is the organization of information within the cognitive structure, which is an important aspect of expertise (Schenk, Vitalari & Davis, 1998). Research has shown that expert knowledge is highly organized in deeply integrated schemas. Schema can be defined as "generic knowledge structures that guide the comprehender's interpretations, inferences, expectations, and attention when passages are comprehended" (Soloway, Adelson, & Ehrlich, 1988, p. 130). The sophisticated and complex knowledge structures allow experts to recognize relationships and meaningful clusters of information during performance and to sort, identify, and analyze the essential factors with precision and proficiency (Chase & Simon, 1973; Chi, Feltovich, & Glaser, 1981). Strahan's (1989) study of expert teachers supported the above statement. He found that expert teachers' knowledge structure is more complex and coherent than novice teachers. They organized their knowledge into more chunks, and created more linkages between chunks. Since experts' knowledge is often organized in a hierarchical and usable way (Ericsson & Smith, 1991), such well-organized structure enables experts to differentiate the important from the unimportant when performing perceptual tasks or making interactive decisions. It also allows experts to access the information easily and rapidly.

Peterson and Comeaux (1987) acknowledged that teachers' knowledge organization is an important factor in experts' perceptual capacities. They indicted that "cognitive psychologists have argued that schemata affect perception, understanding, remembering, learning, and problem solving. Our results indicate that experienced high school social studies teachers have more cognitively complex schemata for classroom events than do beginning social studies teachers" (Peterson, & Comeaux, 1987, p. 329).

Huber's (1999) study investigating the differences between elite and non-elite springboard divers problem representation showed that expert divers possessed a large body of knowledge that was "specific, densely interrelated, well organized, and readily activated". In contrast, the non-elite divers possessed a less complete and limited body of knowledge. "Moreover, this body of knowledge can be characterized as general, rather than specific, sparsely interrelated, less organized, and difficult to access"(p.156). Knowledge of Subject Matter

Knowledge of teaching can be divided into knowledge of subject matter and pedagogical knowledge. Good teaching requires a deep knowledge of the content to be taught (Shulman, 1987). Expertise in teaching is highly specific to context and subject matter. Research has shown that expert teachers possess a wealth of knowledge about the subject matter in the field they are teaching. "The subject matter matters" (Rovegno, 1995). Teachers who possess a thorough knowledge of subject matter could identify and resolve student-learning problems better than novices. They also view students learning problems as challenges and feel confident to provide students remedies to overcome the learning difficulties (Schempp, Manross, Tan & Fincher, 1998). Siedentop and Elder (1989) believe expert teachers' responses to their teaching situations are more subject matter dependent rather than teaching-skill dependent.

Expert teachers possess richly elaborate knowledge about curriculum, classroom routines, and students that allows them to apply what they know to particular cases (Munby, Russell, & Martin, 2001). Where novices may focus on surface features or particular objects, experts draw on a store of knowledge that is organized around interpretative concepts or propositions that are tied to the teaching environment. Expert Knowledge in Coaching

Studies of expert coaches knowledge demonstrated that expert coaches' knowledge is well organized and structured. Cote, Salmela, Trudel, Baria and Russell (1995) studied gymnastic coaches knowledge expertise. They described coaches' cognitive structure as flexible and adaptive with interrelated knowledge of coaching task, coaching process, characteristics of individual athlete, and personal characteristics of the coach and the situation at hand. Experts' knowledge, organized in a hierarchical fashion, allowed them to assess situations rapidly and make changes accordingly.

Saury and Durand (1998) conducted a qualitative research to examine expert sailing coaches practical knowledge. By applying the methods of on-site observation,

simulated recall and semi-structured interview, the authors found that expert coach's implicit knowledge was strongly tied to the coach's past experiences. Experts' coaching activity was highly adaptive in nature. Their coaching planning was very flexible and based on continuous, step-by-step tuning to the context.

McPherson and Thomas (1989) compared novice and expert tennis players on the relationship between their knowledge structure, decision-making and skill performance. A paper-and-pencil knowledge test was used to measure expert and novice tennis player's knowledge of rules, player positions, stroke production, and scoring. They found that expert tennis players have a more extensive context-specific knowledge base, which allows them to use information more effectively during actual game play.

Expert Knowledge Sources

Shepard, Hark, Gwyer and Jensen (1999) have investigated expert physical therapists knowledge, philosophy, and clinical reasons during their clinical practice. They found that fundamentals of the natural and behavioral sciences, knowledge of movement dysfunction, knowledge of the patients, and knowledge of the health care system were types of knowledge expert physical therapy clinicians held. Experts had a desire for continual learning. They would acknowledge the limit of their own knowledge and they understood what they did know and what they need to learn.

Schempp, Templeton and Clark's (1998) study of knowledge sources of golf instructors showed that coaches' knowledge gained from other teachers, from their own teaching and coaching experience, as well as from their students were the primary knowledge sources for experts. Other knowledge sources such as books, workshops, certification programs, journals and magazines, films and videos, formal education, and
popular media were ranked less important. The authors concluded that the knowledge sources were more people oriented and experience based.

Experts' Perceptions

According to Tan (1997), experts have extraordinarily fast and accurate pattern recognition capabilities. This ability allows experts to extract the relevant information from what they are viewing and predict the next series of events or plan for the appropriate course of action.

Expert Athletes' Superior Perception

Quick and accurate pattern recognition and anticipation appear to play an important role in expert perceptional performance. Such ability enables expert athletes, especially in fast speed sports, to anticipate their opponent's actions and enhance their performance.

A study of expert players perception showed that experts demonstrated the unique ability for using early display advance in time to anticipate upcoming performance (Abernethy, 1990). Expert athletes were able to perceive essential information, select correct responses, or initiate and control well-learned actions. They can extract earlier information from dynamic, contextually relevant cues, which may effectively reduce information.

Abernethy (1996) reported that expert field hockey and basketball players are superior to lesser skilled players and novices in recalling the position of both teammates and opponents in the particular play. The findings demonstrated that expert athletes' perception was better by taking the advantage of domain-specific pattern recognition for rapid information acquisition and encoding. The researcher believes that experts' perceptual advantage may be linked directly to domain specific knowledge and its development (Abernethy, 1996).

Expert Teachers' Perception

Expert teachers possess heightened perceptual abilities. Their sensitive perceptual abilities permit them to have early warning detection systems enabling them to make adjustments to prepare for or prevent undesired outcomes (Manross & Templeton, 1997). Carter, Cushing, Sabers, Stein, and Berliner (1988) studied expert and novice perceptions of classroom information and found some differences between the two groups. Results indicated that experts seemed to look at student engagement as an aspect of the particular work the students were trying to do and novices made more general statements about attention or engagement, such as whether the individual students looked "busy". Experts appeared to focus their attention on making senses of anomalies and could relate their viewing of slides to their own classrooms. They made many assumptions about what they saw and used their experience and domain-specific knowledge of pedagogy to interpret the meaningfulness of the events. In contrast, novices provided comparatively "flat" descriptions of the slides. Their descriptions of students and the classroom settings were detailed, but were not characterized by the depth of information. Sometimes, novice teachers failed to make inferential descriptions of what they had seen in the slides. Experts were better able to interpret classroom phenomena than novices. The study suggested that novices schema brought to their visual information processing tasks did not seem as richly developed as that of experts.

Expert Physical Education Teachers' Perception

Graham, French and Woods (1993) studied two teacher educators, seven experienced junior students, and ten pre-service students to seek the differences among those groups when observing and interpreting the teaching-learning process. They had participants watch videotape in which an elementary physical education teacher was teaching a third-grade class. Then, the participants were asked to describe what they have observed in written form. Results showed that expert teachers demonstrated the ability to interpret what they saw in a considerable fuller and richer fashion. They appeared to "see more" and "in greater depth" than did novice students. Expert teachers tended to focus on several dimensions of the lesson. Their interpretation of the lesson was more organized than that of novices. They also focused their observation and lesson evaluation on student motor skill performance.

Another study conducted by Behets (1996) attempted to compare pre-service students and experienced physical education teachers' visual information processing ability. Although no significant differences were found on observational capacities between these two groups, there were significant differences on the number of critical events reported after participants observed slides of one gymnastic lesson. Moreover, experienced teachers correctly reported more critical events than first year student teachers.

In addition, research has shown that experts encode semantically relevant information more efficiently with a higher degree of success than novices did (Werner & Thies, 2000). Expert teachers are "better able to anticipate the possible situations that may be encountered when teaching physical education and generate contingency plans to meet the demands of these situations (Housner & Griffey, 1985, p. 47).

Expert Sport Instructors' Perceptual Capacities

Woorons (2002) studied four expert and four novice tennis instructors' perceptual capacities. She found several distinct differences between experts and novices in their critical motor skill and instruction analysis. Expert instructors' perception was considerably more selective than the novices. Their perceptual focuses were more on the cues relevant to the skill and instruction, which showed that same result in their cue interpretations and evaluations. Contrasted to the novice instructors who provided more detailed and descriptive information on what they have observed, expert instructors tended to be more critical and analytical. The extensive knowledge of experts enables them to recognize important cues and sometimes predict what's about to happen the next. The researcher also pointed out that experts had the ability to recognize important cues. They "would compare the instruction or motor skill to an internal image or standard, justify their critique, and offer suggestions for improvement. In some instances, experts would explain what was to be anticipated if the problem remained or how their suggestion would influence the outcome" (Woorons, 2001).

Expert Decision-making Process

How do experts and novices differ in their decision-making or problem solving process? Research focused on this topic has shown some differences between experts and novices in various domains.

Expert Teachers' Decision-making Process

Swanson, O'Connor and Cooney (1990) investigated the differences between expert and novice teachers in their classroom problem solving cognitive process. Researchers applied think-aloud protocols to ask each teacher to think, reason in a loud voice of their thought process pertaining to classroom discipline problems. Results showed that in terms of the solutions, expert teachers were more likely to rely on environment interventions when compare to novice teachers. They tend to use strategies such as means-end analysis, systematic search, and use of feedback and pattern extraction more frequently than novice teachers. Expert teachers have a well-established procedural plan of resolving discipline problems and clearly emphasized means-end analysis.

Expert teachers place a priority on defining and representing the problem, as well as evaluating possible strategies, whereas novice teachers tend to represent problems in terms of their possible solutions (Swanson, O'Connor, & Cooney, 1990, pp. 548).

By using a naturalistic approach, Graham and his colleagues (1993) interviewed and observed physical education teachers prior to, during, and after the instructional practice to study interactive decision-making differences between experts and novices. They indicated that both novice and expert teachers are situational decision makers. Experienced physical education teachers relied more on past experience to plan their lessons instead of written resources. They spent more time developing tasks based on their observation of their student needs. They also devoted more time to fewer tasks, and provided more learning cues during the lesson. Providing more information cues during teaching practice by expert teachers and coaches is one of the characteristics identified by other studies. Housner and Griffey (1985) found that expert teachers provided more information pertaining to motor skill acquisition to students to help students improve their motor skill performance than inexperienced teachers. Expert golf instructors were very skillful in questioning students at the beginning of the lesson. They could capture the critical information provided by the students and make good use of that information to personalize the lesson to meet the student's needs (Baker, Schempp, Hardin, & Clark, 1998).

Expert coaches' Decision-making Process

A study on coaches' behavior and interactive decision making indicated that experienced coaches exhibited significantly more technical instruction. Experienced coaches focused on more skill performance when coaching and provide athletes more skill-related information and feedback. Inexperienced coaches, on the other hand, demonstrated higher frequencies of silence, which indicated that novices were unable to detect skill performance errors and provide appropriate feedback on time (Jones, Housner, & Kornspan, 1997). The authors explained that expert coaches had more experience analyzing motor skill and were better able to anticipate and diagnose skillrelated problems than novices.

Motor Skill Diagnosis as a Decision-making Process

Hoffman (1983) considered motor skill diagnosis as a decision-making process. Coaches and teacher need to meet three major decision goals to correctly detect learner's technique problems and provide remedies for skill improvement. These three major decision areas included 1) decide whether or not the learner has performed the skill correctly; 2) decide which features of the performance are in error; 3) decide to make clinical decisions regarding prescriptions for remediating the primary errors. Hoffman pointed out that "a teacher's ability to correctly ascertain the learners' problems, and allow that assessment to inform subsequent decisions about the prescriptive part of teaching would appear to be a major determinant of his/her effectiveness in helping learners attain the skill goal" (p.36). The author expressed the research need to study the differences of expert and novice decision-making process in motor skill diagnosis.

Characteristics of Expertise

Characteristics of Expertise in General

Studies across different domains attempt to find unique characteristics and common qualities of experts in comparison to the novices. Tan (1997) summarized the characteristics of expertise by reviewing consistent findings of different studies. According to Tan, a) experts possess an extensive knowledge base that is organized hierarchically. They make a significant investment in learning about their field. They work forward from known facts to the unknown when solving problems. b) Experts have acute perceptual capacities. c) They demonstrate automaticity of behavior, which is the result of intensive years of practice. d) Experts have extensive memory in their domain. Their knowledge organization together with their automaticity of behavior allows them to focus and remember more of current events. e) Experts use self-monitoring skills, specifically, they are more aware of their errors. f) Experts were able to accurately predict which problem will be more difficult. They understand why they fail to comprehend certain elements of the problem. g) Experts are aware of the appropriateness of their solutions; they are able to identify their shortcomings and realize the cause of their failure.

Glaser (1987) listed a series of what he called generalization and speculations on the characteristics of expertise. He found that experts have experienced:

A continuous development of competence... expertise seems to be domain specific... the knowledge of experts is highly procedural and goal oriented...experts have developed skilled self-regulatory processes... the precision of expert performance results from specialized schemata... the development of expertise is influenced by task demands constrained by environmental requirements (Glaser, 1987, p. 90-91).

Berliner (1994) has reviewed some expert characteristics as follows: (a) expertise is specific to a domain, developed over hundreds and thousands of hours, and it continues to develop; (b) expert knowledge is structured better for use in performances than is novice knowledge; (c) experts represent problems in qualitatively different ways than do novices; (d) experts recognize meaningful patterns faster than novices; (e) experts are more flexible, and can change representations faster when it is appropriate to do so, and (f) experts develop self-regulatory processes as they engage in their activities (p.163). Characteristics of Expertise in Coaching

De Marco & McCullick (1997) described five characteristics of expert coaches by studying the previous research on coaching effectiveness, coaching expertise, and expert performance. They are:

- 1. Expert coaches possess and draw upon extensive, specialized knowledge, which gathered from many years of experience.
- Expert coaches organize knowledge hierarchically. They possess the ability to store and organize knowledge about their sport and athletes in long-term memory as learned patterns or schemata.
- Expert coaches are highly perceptive and superior problem solvers. They are uniquely capable of accurately perceiving stimuli in game situations and athletic performance.
 Expert coaches are able to detect what athletes need to know and then find ways of supplying that information
- 4. Expert coaches exhibit automaticity during analysis and instruction. Expert instructional approaches are more fluid, cohesive, and efficient as a result.
- Expert coaches have self-monitoring skills. Expert coaches appear to be more aware, analytical, evaluative, and corrective of their own performance. They have strong desire of self-improvement. (pp.37-41).

Characteristics of Sport Experts as Compared to Novices

Singer and Janelle (1999) summarized six characteristics of sport experts from previous research as follows:

- 1. have more elaborate task-specific knowledge;
- 2. make more meaning of available information;
- 3. encode and retrieve relevant information more efficiently;
- visually detect and locate objects and patterns in the visual field faster and more accurately;
- 5. use situational probability information better; and

6. make more rapid and appropriate decisions. (Singer & Janelle, 1999, pp. 121)

Characteristics of the Expertise from A Behavioral Interpretation

Siedentop and Eldar (1989) have addressed five characteristics of expertise from behavioral perspective in their paper addressing teaching expertise, experiences, and effectiveness. The authors, first, indicated that expertise is primarily a matter of fine stimulus control. Experts can "see things" that novices don't see, which means that experts have developed considerably finer discriminatory capacity that enables them to respond differently to slight changes in the context. Second, the automaticity they have developed through years of practice in similar situations enable experts to respond to the stimulus quicker than novices do. They also have larger response repertoires and are more subject-matter dependent. Expert teachers are "plan independent" and novice teachers are more likely "plan dependent". Lastly, experts can articulate and rationalize their performance and development of the expertise as a function of a verbal community. The constant interaction and discussion of their performance with their mentors enhanced the development of expertise. The authors believe that "expertise is performance oriented...the essence of expertise is not only in the ability to articulate or rationalize performance but rather in the performance itself" (Sidentop & Eldar, 1989, p. 257).

Summary of the Literature Review

In summary, previous studies have established a solid theoretical framework by using the expert/novice paradigm to study the differences of cognitive procession between experts and novices in many domains. One of the area of study is experts' diagnostic ability, which is a process involving knowledge and its organization, information cue perception and interpretation, and problem solving. Research showed that expert coaches demonstrated a superior knowledge base by using more holistic and process-based diagnosis than novice coaches (Leas & Chi, 1993). Experts were more schema driven in their diagnosis. They had more refined schema that allowed them to make better discriminations. Experts' automatic-recognition capability enabled them to have more accurate cue interpretations (Lesgold, et al, 1981). Experts' knowledge organization facilitated movement diagnosis and provided them with acute perceptual capacities (Pinheiro & Simon, 1992; Woorons, 2001). They intended to focus their attention on the cues they considered significant and to ignore those judged unimportant. Experts "see things differently" than the novices (Lesgold et al., 1981), they appeared to "see more" and "in greater depth" (Graham, French & Woods, 1993). Expert coaches considered the analytic diagnostic skills in sport instruction as essential pedagogical tools to enhance learning (McCullick, 1999). In summary, experts have demonstrated many characteristics in common across different domains from previous studies.

CHAPTER 3

METHODS AND PROCEDURES

This study has examined expert and novice volleyball coaches' diagnostic ability on a selected volleyball skill by applying three interviewing methods in order to answer the following questions:

1. How does expert volleyball coaches' knowledge of the volleyball spike differ from novice coaches?

2. What are the differences in information cue acquisition and interpretation between expert and novice volleyball coaches?

3. How do knowledge structures contribute to diagnostic differences between expert and novice coaches?

4. What are the differences between expert and novice diagnostic decisions regarding their corrective suggestions for performance improvement?

Participants

Four expert and four novice volleyball coaches were invited to participate in this study. Previous studies comparing the differences between experts and novices often applied an in depth qualitative approach with relatively small sample sizes (e.g. Lubbers, 1998; Leas & Chi, 1993; Nelson, 1988; Solmon & Lee, 1991; Woorons, 2001). This research was designed to be qualitative in nature. The sample size in the present study can be considered adequate because the primary goal is to gain insight into the participants' diagnostic ability rather than to estimate a population value.

Selection of Expert Coaches

Four expert and four novice Iowa high school volleyball coaches participated in this study. "Expert performance is defined as consistent superior performance on a set of relevant tasks in a specific field of human activity" (Tan, 1997, p. 30). Years of experience and deliberate practice in a specific domain (Ericsson's 10-year rule of necessary preparation, 1996) are among some important indicators of the expertise. Defining the criteria for expertise in coaching and teaching is not as simple as selecting experts from elite athletes, famous musicians, or master chess players whose performance excellence becomes a very strong indicator for expertise. Therefore, a multiple-standard method was often used in expert coaches and teachers selection (Jone, Housner, & Kornspan, 1997; Salmela, 1995; Solmon & Lee, 1991; Saury & Durand, 1998; and Woorons, 2001). These criteria for choosing expert coaches often include:

- 1. The number of years of coaching experience
- 2. The performance levels achieved by their athletes or teams
- 3. Prolonged coaching success
- 4. Recognition of their expertise by peers

Four expert coaches were selected according to the standards set up as follows: Standard one: Has coached at high school level or above for at least 10 or more years.

In this study, expert coaches have 19.75 years of coaching experience in average ranging from 14 years to 24 years.

Standard two: Has a consistent winning record during the course of 10 years or more.

Expert coaches in this study have demonstrated successful and consistent coaching records throughout their high school coaching career. Coach Barbara Bakker,

who started her coaching career in 1979, coached Dike-New Hartford High School capturing seven State volleyball Championships (1A) and five runner-ups. Coach Tom Keating, the head coach and athletic director of Wahlert High School, Dubuque has led his team to win eight State Championships (3A) with a coaching record of 660 wing and 75 loses. Both expert coaches Lori Schaal and Teresa Kehe have taken their volleyball teams to the State tournament five times in a row since 1998. In addition, all four expert coaches had players named to the Iowa State's Elite Team, which is the highest ranked team in Iowa high school volleyball.

Standard three: Recommended by other peer coaches from colleges.

Letters seeking peer coaches recommendations were emailed to 10 universities and colleges in Iowa. College level head coaches were asked to name the four or five best Iowa high school volleyball coaches based upon the years of coaching experience and performance levels achieved by their athletes or teams. Five university or college coaches responded to the request. All four expert participants were among the most frequently recommended coaches by their peers.

<u>Standard four</u>: Recognized as an outstanding coach by organizations (e. g. coach of the year).

Four expert coaches were named as the Coach of the Year at state level at least once. They are all multiple "Coach of the Year" award receivers. In the year 2002 (after data collection was completed), coach Tom Keating was awarded as Iowa Class 3A Coach of the year and Northeast Regional Coach of the Year. Coach Barb Bakker was recognized as 2002 Central Regional Coach of the Year. Coach Teresa Kehe became the West Regional Coach of the Year.

		Exp	ert			Nov	vice	ice		
	One	Two	Three	Four	One	Two	Three	Four		
Coaching Experienc e (Year)	24	21	20	14	1	4	2	4		
Coaching Record (W-L)	732-150	660-75	430-12	298-127	12-9	40-27	0-9	No report		
Honors and Awards Received (reported by the coaches)	Iowa coach of year 3 times Nationa l coach of year nomine e for 3 times	National coach of year. Finalist 2000- 2001 Iowa state coach of year, 1989, 1995, 1996, 2000,	Class 1A Coach of the year in Iowa, 99, 00, 01 Coach of Sr. All- Star match 1999	FCA coach 1991 NE All- Stars 97 Iowa All-Stars 2001 Coach of the year 1999 Regional coach of year 99, 00, 01	None	None	None	None		

Table 3.1. General Information of Expert and Novice Coaches

Recruit Novice Coaches

Four novice participants are all current high school head volleyball coaches with 2.75 years coaching experience in average ranging from 1 to 4 years. They all received a coaching endorsement for their coaching position, which is a mandate in the state of Iowa (See Table 3.1).

In order to keep a gender balance, each coaching group consists of three female coaches and one male coach. Two expert coaches and one novice coach are from Iowa 3A high schools, which student enrollment for grade 9 to 11 are more than 470, according to 2002 school year classification. The rest of the coaches (two experts and three novices) are from 1A schools where enrollment in each school is less than 220 students.

Procedure

All coaches were very supportive and eager to participate. The researcher continued to communicate with the coaches until the interview date and location were scheduled for the convenience of both sides. Interviews with six participants (four experts and two novices) were conducted at their respective schools. The other two were carried out at the researcher's office at the University of Northern Iowa.

During the meetings with coaches, the researcher first greeted the coach and provided the *informed consent form*, which was approved July 2, 2002 by the University of Georgia Office of the Vice President for Research (See Appendix A) to the participant. While the coach signed two copies of the informed consent forms and completed a general information questionnaire, the researcher set up equipment for the interview tasks and answered the questions proposed by the coach.

Three tasks were used in the study to collect coaches' verbal reports as data resource in order to capture the coach's diagnostic ability. The use of verbal data to study cognitive processes and expertise has increased since the 1980s. The rational for considering verbal report methods as a valid tool in data collection is that "individuals had privileged access to their experiences; as long as they were truthful, their reports could be trusted" (Ericsson & Simon, 1993, p.xii). Examination of studies on verbal report approaches indicated that both concurrent reports and retrospective reports provided powerful means for obtaining information of specific cognitive process (Ericsson & Simon, 1993).

After the researcher read information about the data collection procedures, the coach was asked to describe an ideal volleyball spiking skill technique and to list components they perceive to be important for a good spike execution.

In the second task, the coach performed a recall test by viewing four slides, which contained volleyball-offense images under different game situations. Images selected for the recall test were from USA Volleyball Magazine following the criteria set below:

- a. Spiking is the major theme in the picture
- b. There were more offensive and defensive factors involved in the picture
- c. It is performed by female players

During the interview, the coach viewed each slide for ten seconds. After the slide disappeared from the computer screen, the coach was asked to report what he or she observed as much as possible. The next slide would be presented once the participant finished his or her retrospective report.

The third task was designed to capture coaches' diagnostic ability. The researcher presented two video clips of a female volleyball spiking technique, which were edited from a female student's single spiking action being taped from two different angles (See Figure 1). After the researcher demonstrated how to use the QuickTime to view the video clip, the coach was asked (1) to provide a general assessment of the player's spiking skill; (2) to analyze and diagnose the athlete's spiking technique, and (3) to provide suggestions on what she should work on to improve her skill.

Performing Tasks	Estimated Time to Complete
Orientation meeting and inform consent form	10 minutes
Questionnaire completion	10 minutes
Interview on an ideal volleyball spike	25 minutes
Recall test	10 minutes
Skill diagnosis	25 minutes
Total for each participant	80 minutes

 Table 3.2.
 Data Collection Procedure and Schedule

Each expert and novice coach was informed to take as much time as they needed in viewing video clips and providing verbal report. The researcher asked probing questions to ensure the participant's report was complete and understood. Each coach's verbal report and non-verbal demonstrations were audio and video taped through the data collecting process. All the interviews were completed within 80 minutes as estimated previously.

Task Selection

In the present study, volleyball spiking technique was selected as the testing task to capture the differences of the diagnostic ability between expert and novice volleyball coaches. Spiking in volleyball is the most prominent skill that can be very effective to terminate the rally in favor of the attacking team. It is a very complex and difficult individual skill that requires an enormous amount of practice to master. The nature of the spiking technique requires "a great deal of body control and coordination while the spiker's body is airborne" (Haley, 1997, p. 77). Powerful and effective spiking depends on the correct execution of a spiker no matter how complicated the offensive combinations the team plays. Poor spiking technique can have adverse effect on the players. Dr. Iradge Ahrabi-Fard, former head coach of the University of Northern Iowa and 2000 Coach of the Year in the American Volleyball Coach Association indicated that a strong approach, an appropriate takeoff, a powerful jump, a skillful and quick swing of the arm, an effective contact of the ball, and the landing are six important components in spiking execution (Ahrabi-Fard, 1990).

Video clips for skill analysis were chosen from several spiking actions performed by college students during 2002 Spring semester. Eight college students who attended an intermediate volleyball class at the University of Georgia in spring 2002 agreed to perform volleyball spiking for the study. Two digital cameras were used to capture spiking performance. The first video camcorder was set up about 30 feet away from the net along volleyball sideline for capturing the spiking performance from a back angle. The second camcorder was located close to a 10-foot line on the right side of the volleyball court for the side angle shooting (See Figure 1).

Figure 1. Video-clip shooting illustration

0	Camera
\square	Setter
\diamond	Player



Pilot Study

A pilot study was conducted to refine the testing protocols of testing tasks and estimate the time demand. Two volleyball coaches were invited to participate in the pilot study. Interviews on an ideal volleyball spike descriptions, a recall test, spiking skill diagnosis, and a volleyball game-situation evaluation were four tasks used in the pilot study. Coaches were asked not only to perform the tasks, but also to provide feedback on testing protocols and procedures.

A few testing protocol questions were reconstructed because the pilot study revealed some questions were ambiguous. Additionally, result of the pilot study revealed a need for using a video camera to record the whole testing process, as coaches often using non-verbal movement to support their technique statement and sometimes to pin point a certain action phase on the screen. For example, when one coach provided her analysis as:

You want your arms to stay back behind you at this point. So you are dipping down, and now your arms come back. Her arms are already back. So her feet/arm rhythm is off. So in this phase right here is when your arms should be behind you. Now in this jumping up phase, is when your arms come forward. Does that make sense? So that what I will teach her is really to focus on the better arm rhythm.

It was difficult for the researcher to comprehend content such as "*this* point", "right *here*" and "in *this* jumping up phase" without video image support. Adding a video camcorder during the interview and capturing the image of "this point" enabled the researcher to understand the coach's verbal and nonverbal report correlation. One experienced coach in the pilot study indicated that the fourth task, which is requiring the participant to watch a video-taped volleyball game and provide evaluations on the team's offense and its hitters, was not in line with the other three interview tasks. She thought that the fourth task "doesn't seem to fit with the other part of this setting." She mentioned:

I would like to just stay technical to the outside hitter instead of bringing in many game components, because you have so many variables to it. This part here (the first three tasks) is pretty black and white. That fits the theme. And then

when you come with that (the fourth task), it really doesn't fit the theme anymore. According to the coaches' commends and suggestions, the forth task was eliminated from this study.

Data Analysis

This study examined volleyball expert and novice coaches' diagnostic ability of a volleyball skill. The data analysis were carried out to provide information to answer the following questions:

1. How does expert volleyball coaches' knowledge of the volleyball spike differ from that of novice coaches'?

2. What are the differences in information cue acquisition and interpretation between expert and novice volleyball coaches?

3. How do knowledge structures contribute to diagnostic differences between expert and novice coaches?

4. What are the differences between expert and novice diagnostic decisions regarding their corrective suggestions for performance improvement?

Coaches' audio-taped verbal reports were transcribed and sent to the coaches for member check. Descriptions of coaches' non-verbal actions captured by the video-tapes were added to coaches' transcripts where they indicated "here and there" during the interview. Coaches were asked to determine if the transcript represented their intention and statements. Changes were made based on coaches' suggestions and comments of the returned transcripts.

First Task

The first task was designed to exam the coach's perception and knowledge structure of the ideal volleyball spike. Based on Abendroth and Kras (1999) biomechanical based observation and analysis method, a volleyball spiking technique is divided into four phases: approach, jump, attack and follow through. Under each individual movement phase, a list of subcategories was developed according to the Abendroth and Kras (1999) model. The researcher first put each coach's statement that related to the spiking technique into a checklist cell that fit the subcategory. Next, she read each transcript a second time and coded it using the same checklist. Out of 132 components stated by the coaches, there were 119 statements that agreed with each other. Intra-coder agreement was reached above 90 percent (119/132 * 100% = 90.15) Second Task.

The recall task was used to investigate information cue acquisition and interpretation differences between expert and novice coaches from a volleyball game situation. Transcripts of coaches' verbal reports and non-verbal reports were coded following the encoding matrix (See Table 3.3) developed by the researcher. 45

	Descri	ptive	Evaluative			
	Expert	Novice	Expert	Novice		
Relevant to the technique						
Relevant to the game						
Non-relevant						

Table 3.3. Data Analysis Matrix for the Recall Test

A statement or a phrase was coded as "descriptive" when the participant provided information about the events on each slide. A statement or a phrase was coded as "evaluative" when the coach offered the comments on an event in an analytical manner. Statements or phrases used to describe the spiking technique were coded to fit "relevant to the technique/descriptive" category. Statements or phrases used to analyze the team offense other than spiking technique were grouped into the "relevant to the game/evaluative" category. Numbers of relevant and non-relevant cues pertaining to the volleyball offense were reported for examining information cue acquisition and interpretation between expert and novice volleyball coaches.

Third Task

The skill diagnosis task was designed to examine coaches' diagnostic ability. Data analysis from this section were conducted to explore the differences in coaches' information cue acquisition and interpretation, the connections between the coaches' knowledge of an ideal volleyball spike and their diagnostic performance, and the differences in coaches corrective suggestions for the performance improvement. According to Pinheiro and Simon's (1992) skill diagnosis model, the information cue acquisition and interpretation for skill analysis depends on the coach's systematic observation of the motor skill, with emphasis on the comparison between the actual performance and the ideal model stored in the coach's memory. Transcripts of coaches' skill analysis were reviewed and analyzed. The general skill evaluation and errors identified by the participants were reported. Coaches' corrective suggestions were also used to provide answers for research questions proposed in the present study.

CHAPTER 4

FINDINGS

The purpose of this study was to examine expert and novice volleyball coaches' diagnostic ability on a selected volleyball skill. This study proposed to provide answers for the following questions:

1. How does expert volleyball coaches' knowledge of a selected volleyball skill differ from that of novice coaches'?

2. What are the differences in information cue acquisition and interpretation between expert and novice volleyball coaches?

3. How do knowledge structures contribute to diagnostic differences between expert and novice coaches?

4. What are the differences between expert and novice diagnostic decisions regarding their corrective suggestions for performance improvement?

This chapter reports results of the data analysis in order to provide evidence to answer questions proposed in the present study.

Knowledge Base

In this part, transcripts of coaches' interviews to describe and discuss an ideal volleyball spike were used for data analysis to examine the differences in knowledge base pertaining to a volleyball spike between expert and novice coaches.

By applying checklists developed for data analysis, components related to a volleyball spiking were tallied and summarized. Results of the comparison show

differences in coaches' knowledge about an ideal volleyball spike in many aspects such as the total number of components, body part vocabulary usage, the critical components identified in each skill execution phase, and the way coaches discussed skill execution and coaching.

Knowledge of Volleyball Spiking in General

Table 4. 1. illustrates components expert and novice coaches cited when asked to describe an ideal volleyball spiking skill. The average number of components cited by experts was 21.75, whereas novice coaches reported an average of 11.25 segments. Expert coaches almost doubled the number of skill-related components at each spiking phase compared to that of the novice coaches. This result has suggested that experts demonstrated a richer knowledge base considering the overall spiking technique, while novice coaches' knowledge of volleyball spiking on each major category was relatively limited.

		Expert				Novice				
	One	Two	Three	Four	Ave.	One	Two	Three	Four	Ave.
Approach	5	8	6	7	6.5	5	5	0	3	3.25
Jump	5	9	5	7	6.5	2	6	1	4	3.25
Attack	5	8	7	5	6.25	3	4	2	4	3.25
Follow through	2	2	2	5	2.75	1	1	3	1	1.25
Overall	17	26	20	24	21.75	11	16	6	12	11.25

Table. 4. 1. Frequency of Technique Components Cited for an Ideal Volleyball Spike

Every participant except one novice coach identified at least one component in all four major spiking phases. Both groups tended to report more components related to the approach, the jump, and the attack phases and fewer components for the follow through phase. Since the average number of components of the following through phase was considerably lower than other phases, it does not lend itself to a more detailed analysis. Vocabulary Usage

The actual execution of a volleyball spike involves many body parts working sequentially and simultaneously from the beginning (preparation for approach) to the end (following through and landing). Examining how coaches applied body part vocabulary to support their description of a motor skill may show evidence to support the statement that expert coaches process greater knowledge on the volleyball spike. In data analysis, the researcher developed a list consisting of possible body parts used for a spike execution, and then searched and tallied the frequency of each body part with the help of the Microsoft Word finding function. Results from Table 4. 2 revealed that expert coaches as a group referred to 21 different body parts during the interview. Novice coaches, on the other hand, mentioned only 11 different body parts. One expert coach addressed 17 different body parts while talking about an ideal volleyball spike. Most novice coaches referred to 6 or 7 body parts at the most. Body parts mentioned by three or more expert coaches are arm(s), body, elbow, foot (feet), hand(s), hips, shoulder, and wrist. Arm(s), hand(s), and wrist are three body parts cited by three or more novice coaches. Results revealed that expert coaches referred to more body parts in their motor skill description, which demonstrated a richer vocabulary and knowledge base about an ideal volleyball spiking technique and its execution than novice coaches. Furthermore, body parts mentioned by most expert coaches cover lower (foot, or feet), middle (body,

and hips), and upper (hand, elbow, shoulder, wrist) body area, whereas the majority of novice coaches focus more on upper body part (hand, arm, and wrist).

		Ex	kpert		Sum of		Novice				
					frequen					frequen	
	One	Two	Three	Four	cy	One	Two	Three	Four	cy	
Arm(s)	9	8	31	10	58	1	13	2	5	21	
Back	0	0	2	0	2	0	0	0	1	1	
Body	9	2	4	1	16	0	2	3	0	5	
Forearm	0	0	2	0	2	0	0	0	0	0	
Elbow	9	0	20	5	34	0	0	0	0	0	
Eye	0	0	1	0	1	0	0	0	0	0	
Foot, feet	8	7	8	7	30	2	14	0	0	16	
Finger(s)	0	2	1	0	3	0	0	0	0	0	
Hand(s)	3	17	10	2	32	5	4	0	3	12	
Head	0	1	0	0	1	0	0	2	0	2	
Heel(s)of foot	0	0	3	1	4	0	0	0	0	0	
Hip(s)	0	3	1	3	7	0	0	0	0	0	
Knee(s)	0	2	0	0	2	0	0	0	1	1	
Leg(s)	0	0	0	1	1	0	0	0	0	0	
Joint	0	0	2	0	2	0	0	0	0	0	
Muscles	0	0	14	0	14	0	0	2	0	2	
Shoulder	2	9	8	8	25	0	0	10	1	11	
Thumb	0	0	0	1	1	0	2	0	0	2	
Toe	0	0	0	0	0	0	0	0	1	1	
Torso	0	0	1	0	1	0	0	0	0	0	
Trunk	0	0	0	0	0	0	0	0	0	0	
Weight	0	0	2	0	2	0	0	0	0	0	
Wrist	1	0	7	6	14	0	2	15	3	20	
Total number	7	9	17	11	21	3	6	6	7	11	
of cited body											
parts											

Table 4. 2. Frequency of Body Part Usage by Experts and Novices

Note: Bold numbers represent majority responses

Knowledge of Each Spiking Phase

The spiking technique is one of the most complicated volleyball skills. Most participants in the current study described the technical components through four skill execution phases: approaching, jumping (taking off), attacking (arm swing and body position), and following through. In the following section, coaches' knowledge about each major skill execution phase was examined and reported.

Approach phase

Approaching is the beginning of the volleyball spike. A good approach allows players to jump to their best potential and attack at the highest point of the jump. In addition, a good approach enables hitters to have an optimal body-ball relationship to attack effectively in all possible directions.

		Exp	pert		Su	Novice				Su
	1	2	3	4	m	1	2	3	4	m
Approach		У	у		2	у	у		у	3
Angle of attack		у		у	2					0
Ball position					0		у			1
& Height of set										
Transition				У	1					0
Position before:										
dig, defense, block										
Move outside					0	у	у		у	3
Start with proper		У		У	2		У			1
foot										
Footwork	У		У		2	У				1
Two to four steps	У	у		у	3				у	1
Short to long steps		у	у	у	3					0
(tempo of the step)										
Left-right-left	у	У	у	у	4	у	у			2
For right handed	у	у	у	у	4					0
See the ball					0	у				1
Timing	у	у	у		3					0
Total	5	8	6	7	26	5	5	0	3	13

Table 4. 3. Components Cited by Experts and Novices in the Approach Phase

Note: Y represents component identified.

In the approaching phase, expert coaches addressed more components (an average of 6. 5) in approaching than novice coaches (an average of 3.25). Components that were cited by three or more expert coaches were *two to four steps*, *short to long steps (tempo of*

the steps), *order of the step (left-right-left)*, *handedness (for a right handed)* and *timing*. *Approach* and *move outside* were the two components that were mentioned by the majority of novice coaches.

Correct footwork (left-right-left for a right handed player)

The proper approach step order is very important for volleyball spiking, especially for younger players who are in a stage of building up fundamental skills. Correct approaching step orders help athletes to position "their body in a proper position to the setter" (Expert one). It is commonly accepted that a spiker should go "left right left" for a right-handed player and "right-left-right" for a left-handed player. Data analysis showed that all four expert coaches addressed the correct approaching steps when talking about an ideal volleyball spiking skill:

- Make sure their last steps, if they are a right handed hitter, they are going left-right-left at the end. So their body is in proper position to the setter (Expert one).
- ... for a right-handed player that should be right-left. And for a left-hander should be left-right (Expert two).
- We want left right left for a right handed player and not let their steps get too big (Expert three).
- When you start the teaching of it, I go left-right-left for our right handed hitter (Expert four).

Expert coaches not only clearly stated the correct approach step order, but they indicated the handedness as well. Only two novice coaches indicated the order of

approach steps. However, they failed to note given which handedness this step order should be considered to be correct.

- Their footwork needs to be appropriate. Right, left, together and whatever the pattern is, it's kind of together (Novice one).
- Right left is just foot mechanics, to help you in a set to get where you need to be. Some people depending upon if you are left handed or right handed make a little bit different approach (Novice two).

Handedness here became an important factor or indicator to differentiate coaches' knowledge of the spiking approach. The reason for this is that approaching left-right-left can be a good technique for a right handed player. In contrast, a huge skill error or so called "goofy foot" for a left-handed player or vice versa. Since "goofy footed approach" limits spiking power and accuracy (Howard, 1996), handedness becomes a critical assumption for coaches and sport instructors when they introduce and teach the skill. Failure to address handedness could cause confusion and be misleading in learning the approach technique in its correct form. Experts' knowledge of approaching steps may be drawn from their coaching experience through the years. They view correct approaching steps as important, especially for their young players because they find that once the "goofy foot" (approaching right-left-right for a right-handed player) is formed, it is a very hard habit to break.

Number of the steps and approach tempo

Three expert coaches and one novice coach talked about the number of approaching steps during the interview. It seems that expert coaches view the number of steps as a

question of individual personal preference, and as depending upon the situation on the court.

- I think the number of steps you take is preferential to the individual. Some like a three-step approach. Some like a four-step approach. I can live with either of those (Expert two).
- I believe in three steps, but I believe that in the middle sometimes you're just limited to three steps (coach's notes: You don't always need 3 steps, two may be sufficient), you just get as fast as you can (Expert four).

Moreover, expert coaches viewed the approach sequence as an important component, which indicated their knowledge of "how to do it" (an indication of procedural knowledge). For example:

- And I also think that each step should be faster than the step before (expert two).
- You need them to wait, and go fast and explode up to the floor (expert four).

Only one novice coach mentioned the number of approach steps: "There are different steps, either a three step or five steps approach. I teach mainly a three step approach" (novice four). However, what she mentioned was just a simple fact rather than sequence of the approach. No other novice coaches addressed the sequence of the approach.

<u>Timing</u>

Three expert coaches mentioned timing in their discussion. Two expert coaches viewed timing as a crucial factor for spiking because they have seen their players often go in (approach and take off) too early.

- Another thing that I find really hard is working with students for the timing. To me the timing is crucial you find that a young player is going in early (Expert one).
- I think the timing of when to approach is so crucial. A lot of them want to leave too early. And then you are seeing they are waiting and totally off the timing and they don't wait for the ball. It really causes some problems, especially if you are an outside hitter (Expert three).

No novice coaches identified timing as an important component. Instead, three novice coaches cited *moving outside the court before starting approach* as a component related to an ideal volleyball spike approach.

Comparing the components cited by majority of coaches from both groups in the approaching phase, the components cited by the novice coaches were more general and fact oriented. The majority of novice coaches just mentioned *approach* as a general concept or *stay outside the court*, which it is simply a fact that the hitter needs to do before the approach. Expert coaches, on the other hand, not only named more components in the approaching phase, but also their discussions were more procedural knowledge oriented, which related to how to perform the approach correctly. *Correct order of the footwork, the tempo of footwork, timing,* and *handedness as the assumption for the correct steps* identified by experts were more skill-performance specific and

procedurally oriented. In sum, expert coaches demonstrated a more intensive knowledge base and more procedural knowledge on the approach phase than novice coaches in this study.

Jump phase

The goal for spike jump is to transfer the horizontal momentum to vertical momentum by planting in order to reach the maximum vertical height. The movement sequence for jumping involves planting, arm swing to bring the body upward, and jumping straight up in the air to get ready for carrying out an attack.

Table 4. 4. Com	ponents Cited b	y Ex	perts and	Novices	in	the Jum	p Phase

		Ex	pert		Su		No	vice	Su	
	1	2	3	4	m	1	2	3	4	m
Maximum vertical height			у		1			у	у	2
Vertical force										
Summation of joint forces (explode up)	У	У	У	У	4		у			1
Counter movement (hip loaded, knee bend)		у		У	2		у		У	2
Plant foot (step close)		у		у	2	у	у			2
Roll heel to toe		у		у	2					0
Push off (drive)					0				у	1
Vertical velocity										
Momentum transition from H to V		у			1					0
Directional step-plant		у		у	2		у			1
Angle with the ball and net		у			1		у			1
Arm swing										
Upward arm swing during take off	У	У	У	у	4		у			1
Angular displacement	у				1					0
Stay behind the ball	у		у		2					0
Pull up—long arms					0				у	1
Straight up				у	1	у				1
Speed over power		у			1					0
Total components	5	9	5	7	26	2	6	1	4	13

Data analysis of the jump phase indicated that expert coaches reported more skill-related components than novice coaches (6.5 compared to 3.25). *Summation of joint forces*

(explode up) and *upward arms swing during the take-off* were two technique segments identified by all four experts. On the other hand, the novice coaches in general showed little agreement on the components of the jump phase (See Table 4.4).

Only novice coach two talked about this component: "You plant, you take off and explode up in the air with both arms going up in the air (*lifting both arms up higher than the head level) trying to get the height you need." Although two other novice coaches mentioned jumping ability, they failed to discuss how properly performed technique could help a player to jump higher to his or her best potential.

Upward arm swing

Upward arms swing in jumping is another critical element assisting performers to generate upward force and to jump higher. The four expert coaches addressed the importance of the upward arm swing in the jumping phase.

- The arm also has to be involved. Both arms have to be taken into the air in front of the body in order to assist the body in a vertical jump (expert two).
- So use the full arm swing with the shoulder to torque the body (expert one).
- And I think you have to have the correct position of arms driving up (*both arms driving upward) (expert three).

Same as the *summation of joint forces*, only novice two talked about *upward arm swing*.

As stated above, data analysis from the jumping phase indicated that expert coaches reported more components of the jumping movement than novices did.

Summation of the force and *upward arm swing* were two important components of a good jump in the view of all four expert coaches.

Attack phase

Once hitters jump into the air, the attacking includes a sequence of movements for getting arms ready, shoulder rotated, reaching for the ball, contacting the ball, snapping the wrist and following through.

		Ex	pert		Su		No	vice		Su
	1	2	3	4	m	1	2	3	4	m
Position at contact										
Eye-ball-hand contact					0	у				1
Wrist snap	у	у	у	у	4		у	у	у	3
Open hand	у		у		2					0
Slap ball					0	у				1
Shot selection		у	у		2		у			1
Arm momentum			у		1				у	1
Angular velocity of arm		у	У		2		у			1
(pull back elbow)										
Reach up and forward	у	у		у	3				у	1
Trunk and shoulder rotation	у	у	у	у	4					0
Angular displacement of	у	У		У	3					0
arm (high elbow)										
Bow and arrow					0		у			1
Throw arm (arm swing)					0	у				1
Ball Velocity at the contact										
Hit at the peak of flight		у	у	у	3	у		у		2
(keep the ball in front)										
Total	5	7	7	5	24	3	4	2	4	13

Table 4. 5. Components Cited by Experts and Novices in the Attack Phase

Note: Y represents component identified

Table 4. 5. illustrates components identified by expert and novice coaches in the attacking phase. *Wrist snap* is a quick motion in which the heel of the hitting hand contacts the ball first, then the wrist snaps forward and downward with fingers wrapped around. This single component was identified by three or more coaches from both expert
and novice coaching groups. In the attacking phase, expert coaches not only identified more skill-related components, they also agreed on many critical features. *Trunk and shoulder rotation, reach up and forward, high elbow,* and *keep the ball in front* were components identified by three or more expert coaches. Only two novice coaches mentioned *keeping the ball in front,* while for other components, novice coaches agreed little with each other except on *wrist snap*.

High elbow

Three expert coaches considered "high elbow" an important component, because it helps players to generate power when spiking. If a player fails to keep her elbow high, it will weaken hitting power.

Expert coaches indicated their rationales for the importance of keeping the elbow high.

- A lot of girl's elbows are really low, you can not generate the power"...and without high elbow, they are not going to be able to get over the block. Nor can they have the power that they need (expert one).
- ...the critical issue in arm swing is a high elbow. It's important that as both hands reach toward the ball, the elbow of the hitting hand remains higher than the shoulder. Never drop below the shoulder (expert two).

Expert four also indicated that a high elbow could give players more options when they hit. "It is the key for any player to make their best shot." No novice coaches addressed the high elbow issue.

Trunk and shoulder rotation during the arm swing

Before contact, the spiker should rotate the trunk forward, followed by the shoulder and the forearm. This is very important for the hitter to generate the power from the body and deliver it to the hitting hand. During the interview, all four expert coaches cited the trunk and shoulder rotation. No novice coach mentioned this issue, which provides another indicator of knowledge differences between the two groups.

- We call that open and close. Rather than a lean back, then forward, we want open and close (*showing the open action is the body and shoulder square toward the setter's position and close is the body and the shoulders squared toward the net direction). So the torso remains open to the setter until the arm comes forward and then turns toward the net" (expert two).
- The rotation of the shoulder is also important. If right handed, they get their right shoulder back bring the rotation through (expert three).
- And rotating the shoulder, that's where you get your force on the ball (expert four).

Not only did the novice coaches fail to address *trunk and shoulder rotation* during arm swing, their discussion of the motion of the arm swing was rather shallow.

- You know, the swing would be an arm motion (novice one).
- And then to start your swing, some use the philosophy of going to bow and arrow. Pull back (* right arm bent, hand close to the right ear, left arm leading ahead). Bring your arm down. And then you bow and bring your arm through to contact the ball (novice two).

• And good arm swing. The arms extend all the way back. With the nondominant hand. Then reach that to the ball with the dominant hand. Swing through (novice four).

In summary, *wrist snap* was the only component cited by three or more expert and novice coaches in the attacking phase. Again, expert coaches demonstrated a rich knowledge based not only on the number of components identified, but also on the nature of the components that could contribute to a good spike skill. *High elbow* and *trunk and shoulder rotation* are two critical components in enabling hitters to generate more power and to hit the ball at the peak contact point.

Coaching Experiences and Examples

When talking about ideal volleyball spiking technique, many coaches referred to their coaching experiences and provided examples that could support their statements. The data showed that expert coaches provided more coaching examples than novice coaches when talking about spiking technique.

Expert coaches shared their coaching strategies:

We like to show our players the optimum contact point in this manner. If you are right handed, you take your left biceps and place it over your left eye (*showing the contact point as the coach indicated). Then take your right wrist and lay it over your left wrist and then drop your left hand away. That's the optimal contact point for an attack. When we have young players, we use that technique to show them. That's where you want to get your hand to contact the ball (expert two).

Expert coaches mentioned their concern about injuries caused by improper technique.

A lot of kids intend to get the ball over here (* showing that ball is away to the left shoulder). They are off balance. And then the injury is huge. I am having kids with leg, knee and ankle problems because they land off balance (* showing balance off to the left side). But it is all because they didn't do the transition (expert four).

Expert coaches used metaphors in their coaching:

- I use the analogy a lot and I tell the outside hitter: You are more like outfielders throwing the ball from center field to home. So you are lined up, you are throwing (showing the throwing motion). Middle blockers, you are like a catcher. The ball that comes to you. You are going to throw down to second base. Your hand is right here (*showing a very quick motion to get the arm to an bow arrow position). And you are throwing. You've got to get rid of the ball fast. Out-fielders, you've got to throw the ball far (*showing the slower throwing motion). So your arm swing is a little bit different (expert two).
- We tell our players, our young players that after your first step, imagine two foot prints in front of you. And you are going to hop into those footprints, but those prints are on fire. And you are barefoot. So as soon as you hit them, you have to come out (expert two).

Both novice and expert coaches tried to relate volleyball to other sport playing experience to help their players understand the technique better.

• I had a player who...started off this season as a right-handed player going right left right. And she has her steps backwards. And so we worked with

her a lot. We went to the hallway and worked on her approach...She was a really strong basketball player. And I told her that you would not allow, if you were coaching basketball, you would not allow a player to do a lay-up on the right side of the basket with their left-hand right? I had to give her the rationale... And then she was sold on the fact that she needed to change. And then she changed and made the big difference in her swing (expert three).

I try to use an example of, a lot of girls play softball. When you play softball, you don't swing the bat stop here (*showing the bat swing motion and stopping just in front of the body at chest level) and drop. You don't have anything to whip it. You swing all the way through. That's the same thing with volleyball. And you swing all the way through (*showing the bat swing motion with all the way follow-through) (novice two).

Summary of Knowledge Differences between Expert and Novice Coaches

Evidences from both quantitative and qualitative analysis have shown differences among coaches' knowledge of volleyball spiking between expert and novice volleyball coaches. Expert coaches identified more components of volleyball spiking than novices. They utilized richer vocabulary when describing the volleyball spiking technique. Expert coaches have demonstrated their extensive knowledge based not only on the number of components cited, but also on the judgment as to which issues are most critical in skill execution. Expert coaches' explanations about an ideal spike demonstrated more technically specific, and procedure-oriented knowledge. They provided more examples to support their statements, which showed that years of coaching experience played an important role in enhancing knowledge. Novice coaches' comments about spiking, in contrast, appeared to be more general and lacked procedural knowledge. The data on selected components showed individual differences among both expert and novice coaches.

Information Cue Acquisition and Interpretation

The process of cue acquisition and interpretation is an important means of gathering information that can assist coaches in evaluating player performance. Data from recall test and spiking skill diagnosis were used to examine the differences in information cue acquisition and interpretation between expert and novice volleyball coaches.

Relevant and Irrelevant Cues Acquisition and Interpretation

When coaches recalled what they observed of four slides of volleyball spiking images under different game situations, both experts and novices provided their perception almost 100 percent relevant to the technique (e.g. hitter's body position; blocker's hand shape, etc) or the game (e.g. team coverage formation; type of set, etc). Only one expert coach mentioned, "It's a small gym" after she had recalled all technique and game relevant information. Coaches' acquisition of performance cues was highly related to the on-court situation such as the hitter, blockers, the back row players who tried to cover the spiking or defense, rather than other objects (e.g. the referee, the audience, the gym or surroundings). This result is different to findings of Woorons (2002)', who found that novice sport instructors perceived more irrelevant cues than experts when recalling various tennis instruction slides. Overall, the novice coaches made more observational comments than the expert coaches when recalling four spiking slides (154 vs. 94). The result from Table 4.6 revealed that expert coaches provided more evaluative statements on both technique (52.6%) and the game situation (22.3%) than the novices (28.6% and 18.18% respectively). On the other hand, novice coaches provided more descriptive recall pertaining to the game situation (27.3%) and technique (26%) than expert coaches (game, 10.6%, technique 11.7%).

	Expert		Novice	
	Number	%	Number	%
Relevant to the	11	11.7	40	26
technique (descriptive)				
Relevant to the game	10	10.6	42	27.3
(descriptive)				
Sum for descriptive	21	22.3	82	53.2
statements				
Relevant to the	51	52.6	44	28.6
technique (evaluative)				
Relevant to the game	21	22.3	28	18.18
(evaluative)				
Sum for evaluative	72	74.9	72	46.75
statements				
Irrelevant statement	1	1.1	0	0
Total	94	100	154	100

Table 4. 6. Frequency of Information Cues by Expert and Novices (the Recall Test)

Declarative or Evaluative Cue Acquisition and Interpretation

Analysis of coaches' recall of the first slide shows that most coaches noted that the hitter's left shoulder was low. The following evidence indicated the coaches' interpretation of this perceived cue. Three of the four expert coaches pinpointed the improper approach, and take-off position as perhaps leading to this problem, which indicated that experts can go beyond what the image shows.

- The second thing I notice that her left shoulder is very low and her left arm is very low (* lean left side). And her hand is reaching above her head for the ball, which indicate to me that she stepped too far inside instead of outside (expert two).
- She could have lined up her approach a little bit better to get here (*showing shoulder side position). Because she was out here (* on the way left) with it. It wasn't on her shoulder side (expert thee).
- I don't think she had her feet to the ball. Her arm was low, I think by the time she got her arm to the ball, the ball was already dropped. The balance thing I talked about. Her body was out of balance (expert four).

The novice coaches noticed the hitter's shoulder was low, but none of them could relate this problem to the approach and ball-person alignment.

- Her shoulder wasn't dropped too much. Her arm (*left arm) was down (lean her body to the left a bit) but her shoulder wasn't dropped too much...it's pretty good form (novice one).
- That ball may have been set outside a little further so she was trying to bring it back in (*lean toward left) (novice two).
- She must have been following through, maybe, because her left shoulder was way dropped (novice three).

• It looks like that her body was kind of turned out if she had to reach and try to push the ball back in play (*arm extended to the right side of the body) (novice four).

Cue Acquisition and Interpretation for the Spike Diagnosis

Table 4.7 shows that there were little differences between expert and novice coaches in cue acquisition when they attempted to examine and diagnose the approach technique (task three). Both expert and novice coaches perceived the approach from the point of view of *overall approach, approaching steps* and *position toward the setter,* and *the first step*. However, what made experts perceptive abilities differ from those of novice coaches was their interpretations of the cues they saw. Expert coaches interpreted those performance cues as more problematic, while novice coaches read them to be normal or good. Three novice coaches made comment that the performer had a good approach. Table 4.7. Problematic and Non-Problematic Cues Identified in the Approach Phase

	Experts	Novices
Non- proble matic	 Good approach (1) Good time (1) Plant her feet right left (2) Open to the setter (1) Footwork is fine (1) 	 A good approach (3) Move out (2) Three step approach (2) Stay open to set (2) Good first step (1)
Proble matic	 Sitting back on her heels rather than forward (1) Her plant doesn't open to the setter (1) First step is a little bit too far (2) Not a smooth approach (1) Not go from low to high (1) 	

In the jump phase, expert coaches also perceived more problematic cues than the novice coaches. Three expert coaches observed and indicated one similar problem related to timing, a fine tune that is hard for novice coaches to detect.

Table 4.8. Problematic	and Non-Problematic C	<u>ues Identified in the</u>	Jump Phase
			-

	Experts	Novices
Non- proble matic	 Jump (1) Take off is fine (1) Feet to the setter (1) Her heel hits the floor first, not the toe, good sign. (1) 	 Plants (2) Jump straight up (1) Use her both arm to get up (2) Arm swing back (2) Getting down (load) (2) Explode up (1) Left hand up to guide right hand Fine vertical (2)
Proble matic	 Her hips were closing early (1) She closed a little bit early (1) Turning toward net a little bit earlier (1) Not so powerful take off (1) Bending (1) Hasn't bend the knees and lower the hips (1) 	• Knee squat (1)

In the attack phase, novice coaches identified more problematic cues than they did in other phases. *Ball not kept in front, shoulder (or arm) drop, lack of snap* are cues perceived as problematic by both novice and expert coaches. However, expert coaches indicated more technical shortcomings than novices. The result also showed individual differences within the groups. Some coaches viewed the hitter's snap action as nonproblematic, but others perceived it as a technique deficiency.

	Experts	Novices
Non- proble matic	 She has a good extended while she hit it (1) Body position on contact (1) Alignment with the ball is OK (1) At contact, her elbow is high (1) Wrist snap (1) Reach on the top of the ball (1) 	 See the ball (1) Ball in front of her (1) Kept left shoulder up (1) Bring legs together while in air (1) Snapping (1) Bow arrow effect (1) Good swing (2) Hit pretty hard (1) Reach up high (1)
Proble matic	 Ball not in front (2) Needs more snap (1) Not really sharp snap on her swing (1) Left hand should stay up just a little bit longer (1) Her left arm is down already before she is even rotated (1) The velocity of her swing could be stronger (1) Her hand is not on top (1) Leaning to the left (1) Fall a little bit over to the left (1) 	 Shoulder drop (1) Off to one side (left) (1) Snap and follow through at the same time (1) Hit down to the middle (1) Ball not kept in front (2)

Table 4.9. Problematic and Non-Problematic Cues Identified in the Attack Phase

Although both expert and novice coaches perceived fewer information cues in the

follow through phase, a similar pattern was shown as experts interpreted some

performance cues as problematic, while novice coaches did not.

<u>I nase</u>		
	Experts	Novices
Non- proble matic	Good square on both feet (1)Good landing (1)	 Follow through (1) Landing straight back (1) Bring arms through (2)
Proble matic	 Bring down to the middle instead of to the side (1) Off balance when she coming down (1) Not so strong follow through (1) 	

Table 4.10. Problematic and Non-Problematic Cues Identified in the Follow Through Phase

Summary of Information Cues Acquisition and Interpretation

In summary, novice and expert coaches' perception of cues were related both to the skill and to the game situation. Expert coaches' recall statements were more evaluative and technique-related. Novice coaches, on the other hand, were more descriptive and game-situation oriented. Data analysis of coaches' cue acquisition and interpretation when performing a diagnostic task showed that expert coaches were more critical and evaluative. They perceived a greater number of information cues as problematic compared to the novices, especially in the approach, the jump, and the follow through phases. Although novice coaches perceived a similar number of information cues during the skill diagnosis, their cue interpretations regarding the spiking technique were relatively positive and detected fewer errors. Results also show individual differences within each group when coaches provided their diagnostic analysis.

Linkage between Knowledge Base and Diagnostic Performance

According to Pinheiro and Simon (1992)'s sport skill diagnostic model, the recognition of information cues depends on a coach's systematic observation of the motor skill, especially on the comparison between the actual performance and the ideal model

stored in the coach's memory. The coach attempts to find possible meanings for recognized cues. Therefore, coaches' prerequisite knowledge learned and stored in longterm memory is critical for cue interpretation.

Matching Coaches' Knowledge from Two Performing Tasks

In order to examine how coaches' knowledge of ideal technique could contribute to their diagnostic performance, the researcher first listed each coach's statement when analyzing the hitter's spiking skill, and then examined the same coach's first task transcript to match the diagnostic or evaluative statement with the ideal technique model. Table 4. 11 gives a sample of the matching components reported by coaches between task one and task three.

By applying this method above, results of the frequency of coaches catching components (see Table 4. 12) showed that more than 50 percent of novice and expert coaches' diagnostics cue acquisition and interpretation match their knowledge of the reported ideal volleyball spike. Expert coaches demonstrated a higher percentage of knowledge matching in both reported non-problematic and problematic statements (94.44% vs. 75.75% and 80% vs. 50%). Results showed that coaches' knowledge of the skill plays a very important role in their skill analysis.

	Volleyball spike interview	Spike diagnosis
Expert one	You pull your <i>arm down to the side</i> of your body	It Looks like she brings her arm down to the middle of the body
Expert	We do talk about staying open to the	Rather than open and close she is
two	setter until the arms start to come forward. The arms start to come forward then the body closes toward the net. We call that <i>open and close</i> . Open/close, I think is important because otherwise you are going to have back injuries	<i>bending</i> . So Her elbow is dropping. What we were talking about earlier that she is putting stress, I think, on her back.
Expert three	Bringing arm upward and then getting shoulder rotation and you coordinate that all in one motion. We just break down form.	Her left arm is down already before she is even rotated. It's like this comes down instead of all in one.
Expert four	So the approach, <i>I emphases the low</i> <i>to high</i> . Start low, drive in, low to high explode (*showing both arms swing from low to high).	<i>I don't think she goes from low to high.</i> She got some bounce.
Novice one	Their footwork needs to be appropriate. <i>Right, left, together</i> and whatever the pattern is, it's kind of together	<i>One, step right together</i> . She jumps straight up. She got a good approach. She hadn't contacted it yet.
Novice two	And you snap your wrist and bring it down through. Hit it just like this (*showing the arm swing with a pushing and stop motion). (*moving the left hand at a forward motion)	And she's <i>snapping and bring her arms through</i> .
Novice	If you don't do wrist snap (*showing	She had some wrist snap but she kind of
three	the wrist snap motion), you cannot	went all the way through at the same
	put the ball in bound for most people unless the ball is really up front.	time rather than snap and then follow through (*showing the arm swing with and without snapping motion).
Novice	Your arm swing is good enough. And	Her hand was a little bit under the ball.
four	get on top.	

Table 4.11. Examples of Coaches' Knowledge and Their Diagnostic Statements

	Non-Problematic		Problematic	
	Experts	Novices	Experts	Novices
Number of components				
	18	33	20	7
Matching coaches knowledge				
reported in ideal skill	17	25	16	4
interview				
Percentage of matched				
components	94.44	75.75	80	57.14

Table 4. 12. Frequency of Coaches' Matching Components of Knowledge and Diagnostic Statements

Coaches' Reasoning Links

Coaches' knowledge base enables them to provide more reasoning analysis to achieve their diagnostic outcomes. Regardless of diagnostic accuracy, coaches' statements related to their diagnostic findings were used for a reasoning-link analysis. The researcher tallied coaches' reasoning paths to see how coaches reached their final decisions. Each of the reasoning segments that connected one to the other from the beginning (cause) to the final decision (problematic error) or solution (suggestions for improvement) were considered as a reasoning chain. For example, a coach might first notice that the hitter's elbow position is low and then reason that this might be caused by failing to stay open first and by bending. The coach may then take the analysis a step further and point out that the hitter was putting the stress on her lower back. Each of the following statements would be considered a relationship and would be scored as a twolink reason chain. So her elbow is dropping—rather than open and close she is bending—and she is putting stress on her back, which may not bother her for a while. But eventually it is going to take its toll on her.

When the coach ends his or her statement or when they change comments to another component, the chain is finished. The mean length of chains for expert coaches was 3.1 compared to the 2.04 for novice coaches.

In sum, expert coaches demonstrated a higher percentage of knowledge matching in both reported non-problematic and problematic statements (94.44% vs. 75.75% and 80% vs. 50%). Not only did they have more diagnostic findings than novice coaches, but their reasoning chains contained more links than those of novices. Results of the present study showed the connections between coaches' knowledge of the volleyball spike and their diagnostic performance. It appeared that coaches' diagnostic ability depends on the knowledge or schemas pertaining to an ideal volleyball technique.

Diagnosis and Recommendations

Expert and novice coaches' diagnostic analysis and suggestions mainly focused on three spiking components: a) body position when approaching and jumping, b) body position from jump to ball contact, and c) wrist and arm action at the time of ball contact. Coaches' Recommendation Difference: Sequence vs. Point

Expert coaches' suggestions were more procedural and process based. Three expert coaches noted that the hitter had some problems in her approach. All three coaches' suggestions focus on the process instead of a certain point. For example, expert one suggested: "I would suggest going start forwards low, and then go high to build up the speed." In this same manner, expert four provide her final suggestion on this problem: "So wait, and stay level and going low to high and explode up". Such suggestions enable the player to picture the sequence, which constitutes the correct approaching technique.

Novice coaches' suggestions were more focused on a certain point such as *knee squat* or *getting down a little bit*.

- She should get down a little bit more if she can do it. Feel comfortable to help her explode up in the air (novice two).
- She squats down, she could squat down a little bit more...Use her leg a little bit more in stead of just her arm swing (novice four).

Expert Recommendations were Based on More Thorough Analysis and Reasoning

Another problem the coaches noticed and pointed out is the body leaning toward the left side a little bit. Three experts and two novice coaches identified this problem when performing the diagnostic task. Expert coaches provided more intensive analysis after they interpreted this performance cue as a potential technical error. Expert two saw this problem as occurring because the left arm did not keep up long enough, which was caused by the hitter's bending action when it should be a more *open-and-then-close* action. His diagnosis was based on his perception that the hitter's hips closed early. Thus, he suggested that the hitter stay open in the air first so that she could generate more power. That suggestion was process-and-sequence based. Moreover, expert two provided a step-by-step practice remedy for that player to solve this problem.

When diagnosing the spike, expert three viewed the performing cue that *the hitter is leaning a little bit to the left* as a sign of closing early.

She's got her shoulders right in here (*showing her shoulder squared toward net position). She's closed a little bit early. Usually we want to keep their shoulder

open toward where the ball coming from. You can already see, she, her only option is line, because she has closed her shoulder already. She was also on her left.

Her suggestion for solving this problem was to use a little bit more arms to drive up in order to keep the left arm in the air longer. She said: "Her left arm is down already before she is even rotated." This was another sequence diagnosis. Using the arms to drive up could help the hitter to solve the problem of leaning to the left.

Although expert four did not directly point out that the hitter closed toward the net a little bit early, her suggestion reflected the same point.

If I was going to coach her, I would say keep the ball on the right side, go straight up, let's wait when you are in the air, then you decide where you want to go. She is taking out a few options with her leaning.

Jumping in the air and *close a little bit late* will provide a hitter with more options to hit line (ball goes straight down to the line) or across the court (ball goes to the opposite corner of the court). Expert coaches' recommendations were based on their reasoning and coaching experience. They provide more reasonable analysis and suggestive remedies for the hitter.

Novice coaches' recommendations on the same performing cue (*the hitter is leaning a little bit to the left*) show lack of reasoned analysis. Novice one just indicated that the hitter's shoulder is kind of dropped without further analysis. "Just to keep her arm up there" was the suggestion noted by novice coach one. Novice two only pointed out what he observed but he was not so sure whether his judgement was right or wrong.

Just seems she was back up here (*leaning to the left) and trying to hit it. So I guess, I like to see if that's her normal. See another one to see that is her normal body position (novice two).

Expert Recommendations were Related to Their Coaching Experience

Expert coaches' recommendations reflected their rich coaching experience. For example, expert coach two suggested very specific step-by-step practice on how to work on the problem he identified.

On her shot, what I would do is put her on a box and toss the balls to her on the box. Just start her in this position open (* showing the open up position with the shoulders squared to the side), and have her close (*rotating the body from the side toward the net, front), keep her open, have her close and eventually, have her in this position (*reaching both hands up and facing the net). Toss to the ball, have her open and close and then alternatively have her in this position (* hands staying close to the hip level and facing the net), toss the ball and brings her hands up. Open and close. And we take gravity out of it by putting her on the box. She doesn't worry about jump timing. That takes it completely out. Because I think her footwork is fine. I think her take off is fine. I think the issues are stay open to the setter a little bit longer. Then generating power from here (* pointing to the waist) as well as from here (*pointing to the elbow). And then taking some stress off this (*pointing to the lower back). That's what I see.

When performing the diagnostic task, expert one identified three technical weaknesses of that hitter. She revealed her coaching experience by identifying methods

of correcting the player's problems. One of her coaching strategies in correcting skill errors was to work on one problem at a time.

Those are the three main things I wanted to work on. I would first pick one. I would start low and go high. And once she got that mastered, then I would add to the next step. I found out working with junior high or high school students, you cannot bombard them with too many things. You have to just pick out the thing you want to fix the first. And get that taken care of. Then you go to the next thing. For me, if I would say I want to you to start low to high, I want you to snap. I want you go straight by your leg, that's too much information. We need one thing at a time (expert one).

Expert four also mentioned the importance of breaking a skill down and working on it one piece at a time.

I tear down the skills a lot...If I can teach them those seventh graders the correct technique, then you can work on many other things. I put a lot of emphasis on the individual technique... we will stand on a chair and just work on from here (* lower body part: approaching and take off) to here (*showing arm swing)... I start with the toss. And then we set depends on how good our setters are...we just break down and then we progress (expert four)

Breaking down the skill and working on it one piece at a time reflected the coaches' rich experience when working with high-school players. Suggestions among novice coaches indicated limited coaching strategies and experience compared to that of the expert coaches.

Novice Coaches Indicated their Uncertainty when Diagnosing the Performance

In contrast to the expert coaches, who were more confident in their diagnostic decisions and suggestions, novice coaches showed hesitation and uncertainty when analyzing the spiking skill. The following are two examples of statements by novice coaches:

- She's exploding up in the air. So all and all she's a decent approach. I can't, I wouldn't, I don't have the, I want to say the knowledge base to really give her a good critique at great deal more than that. She's got the basic fundamentals done pretty good (novice two).
- She is kind of off the center when she hit. She is kind of, I don't know. I think she is kind of...she lost some power there because she kind of have returned. I don't know. She got her left hand up to guide her shoulder, which is good (novice one).

Summary of Coaches' Recommendations

Compared to the novice coaches in this study, expert coaches' recommendations after their diagnosis were more procedural and process based. Their suggestions were based on more extensive analysis and reasoning and related to their coaching experience. In addition, expert coaches were more confident in their diagnostic decisions and suggestions, while novice coaches showed hesitation and uncertainty when analyzing the spiking skill.

Summary of the Findings

1. Evidence from both quantitative and qualitative analysis showed differences among coaches' knowledge of volleyball spiking between expert and novice volleyball coaches. Expert coaches identified more components of volleyball spiking than novices. They utilized richer vocabulary when describing the volleyball spiking technique. Expert coaches have demonstrated their extensive knowledge based not only on the number of components cited, but also on the judgment as to which issues are most critical in skill execution. Expert coaches' explanations about an ideal spike demonstrated the knowledge that was more technically specific, and procedure-oriented. They provided more examples to support their statements, indicating that years of coaching experience play an important role in enhancing knowledge. Novice coaches' comments about spiking, in contrast, appeared to be more general and lacking in procedural knowledge. The data on selected components showed individual differences among both expert and novice coaches.

2. In the current study, novice and expert coaches' perception of cues were related both to the skill and to the game situation. Expert coaches' recall statements were more evaluative and technique-related. Novice coaches, on the other hand, were more descriptive and game-situation oriented. Data analysis of coaches' cue acquisition and interpretation when performing a diagnostic task shows that expert coaches were more critical and evaluative. They perceived a greater number of information cues as problematic compared to the novices, especially in the approach, the jump, and the follow through phases. Although novice coaches perceived a similar number of information cues during the skill diagnosis, their cue interpretations regarding the spiking technique were relatively positive rather than critical. Results also show individual differences within each group when coaches provided their diagnostic analysis.

3. Expert coaches demonstrated a higher percentage of knowledge matching in both reported non-problematic and problematic statements (94.44% vs. 75.75% and 80% vs. 50%). Not only did they have more diagnostic findings than novice coaches, but their reasoning chains contained more links than those of novices. Results of the present study showed the connections between coaches' knowledge of the volleyball spike and their diagnostic performance. It appeared that coaches' diagnostic ability depends on the knowledge or schemas pertaining to an ideal volleyball technique.

4. In this study, expert coaches' recommendations after their diagnosis were more procedural and process based compared to the novice coaches. Their suggestions were based on more intensive analysis and reasoning and related to their coaching experience. In addition, expert coaches were more confident in their diagnosis decisions and suggestions, while novice coaches showed hesitation and uncertainty when analyzing the spiking skill.

CHAPTER 5

DISCUSSION

This study examined the differences between expert and novice volleyball coaches' diagnostic ability in order to provide answers for the following research questions: (1) How does expert volleyball coaches' knowledge of a selected volleyball skill differ from that of novice coaches'? (2) What are the differences in information cue acquisition and interpretation between expert and novice volleyball coaches? (3) How do knowledge structures contribute to diagnostic differences between expert and novice coaches? (4) What are the differences between expert and novice diagnostic decisions regarding their corrective suggestions for performance improvement?

This chapter provides discussions of findings in this study that related to the body of literature and delineates the practical implications of this relationship.

Knowledge Base

Differences in Knowledge Base Regarding Volleyball Spiking between Experts and Novice Coaches

The findings of this study on coaches' diagnostic ability confirm previous research on knowledge base. Expert coaches not only know more about volleyball spiking technique, they, also, are very knowledgeable on components that are critical for good technique execution. The result that expert coaches cited more skill-related components than novice coaches is consistent with the findings of Leas and Chi's (1991) study on swimming coaches' diagnostic ability. In Leas and Chi's study, swimming expert coaches demonstrated a large knowledge base by identifying a greater number of components pertaining to a swimming skill than the novice coaches. It seemed that experts have a more complete mental picture of the skill than the novices, whose schematic representation was relatively fragmented (Leas & Chi, 1993).

At the core of information-processing theory, is the concept of schema, which is an abstract structure of information stored in memory to represent the generic concepts and standards. As applied to motor skill diagnosis, the schema contains information about all stages of the performance of a targeted skill. In the case of volleyball spiking, it contains components of correct performance from approach, jump, attack, and follow through. Schemas for an ideal spiking technique serve as a norm to allow coaches to compare the actual performance with their norm so that any observed abnormality can trigger coaches' attention for further examination of errors in technique. According to Pinheiro and Simon (1992), schemas used to construct an ideal skill model are developed over a period of years of coaching experience and derived from various sources of knowledge. Findings from the present study have show that expert coaches' schemas regarding the volleyball spike were richer and greater not only in the number of the components identified, but also in the numbers of body parts used to describe the skill. Differences in Critical Components Cited by Expert and Novice Coaches

The results of the current study indicate that expert coaches cited more critical components than novice coaches such as the *handedness* for a correct approaching footwork, *summation of joint forces for take off, high elbow* for arm swing, and *trunk and shoulder rotation* for obtaining power to hit. Knowledge about the important components or critical features of performance is one of the most important areas of knowledge about a motor skill. Jones-Morton (1990a) defined critical features or critical elements as

important aspects of performance that are related to the efficiency and effectiveness of a movement. Results from the present study indicated that expert coaches know more critical components related to volleyball spiking technique than novice coaches. These results mirrored Leas and Chi's study (1993) on expert and novice swimming coaches where they determined that what novices knew "was of lesser importance".

Coaches and teachers need to build up knowledge of the fundamentals of a specific motor skill in order to develop their expertise in a specific domain. A study by Williams and Tannehill (1999) showed that the lack of knowledge of fundamental technique resulted in lower scores for identifying critical errors in incorrect technique. Differences in Types of Knowledge between Experts and Novices

The findings from this study were in line with research showing that the experts not only know more, but also know differently (Prietula, Reltovich, & Marchak, 2000). Results revealed that experts' explanations of technique were more specific, and procedural-knowledge oriented and contained practical examples to support their statements. On the other hand, novice coaches' comments about spiking appeared to be more general and lacking in procedural knowledge.

Clearly declarative and procedural knowledge are critical to expertise (Thomas & Thomas, 1994). Expertise has been defined as "the possession of a large body of knowledge and procedural knowledge" (Chi, Glaser, & Rees, 1982, p. 8). Research indicated that experts' schemas contained more declarative and procedural knowledge specific to the domain of expertise than novices (Chi, Glaser, & Rees, 1982; Leas & Chi, 1993). Although procedural knowledge is dependent on declarative knowledge, the one that has the greatest potential for performance is procedural knowledge. Marshall (1995)

introduced Squire's theory on one central distinctive difference between declarative and procedural knowledge in the brain mechanism involved in knowledge acquisition.

Declarative knowledge is presumed to be acquired directly, usually with one-trial learning. On the other hand, procedural knowledge is considered to be anything that improves with experience or practice (Marshall, 1995, p. 181).

From this point of view, the expert coaches' richer procedural knowledge demonstrated in this study may have been enhanced by their years of successful coaching experience. Research on physical education practice also found that expert teachers' experience, especially in analyzing motor skills, enable them to detect technique errors and provide more skill-related feedback to their students than novices (Graham, et al, 1993). Therefore, it is important to provide practical opportunities and field experience for novice coaches and pre-service physical educators. It will enable them to apply declarative knowledge they learned from classroom in practice and to develop their procedural knowledge in motor-skill diagnosis.

Information Cue Acquisition and Interpretation

Similarities in Coaches Cue Acquisition and Interpretation

Unlike the findings of Woorons' study (2001), that novice coaches perceived more irrelevant cues than expert tennis instructors, novice coaches from this study made their perceptual recall relevant to either technique or game situations most of the time. One possible explanation for this is that the coaches became aware of performing tasks that were related to a selected volleyball skill through reading the *informed consent form* before the interview. Another is that the recall test was arranged as the second task after the coaches were asked to describe an ideal volleyball spike. This could lead coaches to stay more focused on information cues pertaining to volleyball techniques and game situations. The third possible explanation is that all novice coaches who participated in this study are current high school varsity head volleyball coaches. Four interviews with novice coaches were conducted in October during the 2002 Fall volleyball season. Although novice coaches have less experience as compared to expert coaches, they process the basic knowledge of volleyball and coaching that is necessary for their coaching positions.

Differences in Coaches Cue Acquisition and Interpretation

Although novice coaches made more recall statements than expert coaches, their interpretations of the cues they perceived were more descriptive and less evaluative and critical. This result is consistent with Leas and Chi's (1993) statement that experts are able to "see" more than novice individuals. Novices saw the explicit cues, but only the experts realize the importance or meaningfulness of certain patterns. In addition, results of Tan's study (1996) revealed that experienced physical educators perceived a greater number of cues than inexperienced teachers regarding a physical education class situation.

Findings from the current study indicated that the expert coaches' interpretations of perceived cues were more problematic as compared to those of the novices. According to Pinheiro and Simon (1992), expert and novice shot-put coaches demonstrated significant difference in their diagnostic interpretations.

Expert coaches, viewing a single performance of a skilled shot-putter, mentioned an average of 12 cues to errors in performance; novice coaches, viewing the same film, mentioned an average of only 7 cues. The experts proceeded to make an average of six interpretations and diagnostic decisions; the novices made, on average, only two. (p. 291)

Gale and Marsden (1983) found that inexperienced clinicians may fail to interpret information correctly because they lack prerequisite knowledge or incorrectly draw inferences from their knowledge.

Coaches' interpretation of acquired cues differed between expert and novice coaches in this study. Novice coaches tended to point out the problems only within the attack phase. Their diagnostic attention was focused on components of the arm swing, contact point and wrist snap, and follow through. Experts diagnosed problems in all four phases. Three expert coaches mentioned the approach angle and timing of the rotation. According to the Knudson and Morrison (2002), when coaches analyze a skill in which power is generated in a sequential order, experienced coaches tend to find the cause of the error in previous action. For example, if the goal of a volleyball spike is to generate more downward power to make the kill, it is important to know the critical features of the arm swing that relate to body-ball alignment, timing, jump height and the power of trunk rotation. "For performers to have advanced arm actions in overarm patterns, they must have good leg drive and trunk rotation" (Knodson & Morrison, 2002, p. 122). Although most novice coaches perceived some problems in the attack phase, they failed to relate the problems to the previous actions like *approaching*, *take-off* or *trunk rotation*. Expert coaches demonstrated diagnostic competency in applying knowledge of the biomechanical principles of sequential coordination in their diagnostic tasks. This supports Pinheiro and Simon's (1992) view that "accurate description and evaluation of moving body segments are essential to the overall analytic process. The timed, sequential

joint motion and other biomechnical features of the process are major sources of information for diagnosing skills correctly" (p. 289).

Sport-skill diagnosis is a more complex process, which depends on the command of a large body of domain-specific knowledge in order for coaches to find solutions for a technique deficiency. Research shows that experts rarely miss the relevant clues, even the subtle ones. Experts generally attend to cues they consider significant and to ignore those judged unimportant (Pinheiro & Simon, 1992).

Linkage between Knowledge and Diagnostic Performance

Coaches Knowledge Contribution

The results of this study revealed a connection between coaches' description of an ideal volleyball spike and their verbal diagnostic performance reports. Expert coaches demonstrated a higher percentage of knowledge matching in both reported non-problematic and problematic statements (94.44% vs. 75.75% and 80% vs. 50%) when evaluating and diagnosing a selected spiking technique. This finding supports Pinheiro and Simon's (1992) theory about the motor-skill diagnostic information process that coaches need

To recognize variations from a schema in visually presented examples of a motor skill. To make a diagnosis is to compare the problematic technique profile with a standard profile in long-term memory, drawn from all the information available as a result of experience and learning (Pinheiro & Simon, 1992, p.292).

Expert coaches in this study provided thorough description of an ideal volleyball spike with richer vocabulary and more procedural knowledge. As Knudson and Morrison (2002) noted:

Having a good vocabulary or well-defined description based on correct language can help not only with feedback but also with information storage. Chunking of information may explain this storage process. Experts appear to be more efficient

at information storage than novices (Knudson & Mirrison, 2002, p. 68). In addition, experts identified more critical components when describing an ideal volleyball spiking skill. This richer knowledge base played an important role in coaches' diagnostic process because critical elements can serve a role as a parameter for coaches who discriminate errors from an ideal motor skill informational image stored in long-term memory.

Coaches' Reasoning Chain

In the present study, not only did expert coaches have more diagnostic findings than novice coaches, but also their reasoning chains contained more links than those of novices. These findings were consistent with the findings of a previous study that experts are more schema driven and have longer reasoning chains in their diagnosis, which indicated experts were doing more inferential thinking when performing diagnostic tasks. In contrast, novices' diagnoses were more superficial and fragmented (Lesgold, et al, 1988).

Leas and Chi's (1993) study on expert and novice swimming coaches diagnostic expertise revealed that the length of reason chains produced by experts was longer (2.6) than that of novices (1.6). This could be explained by viewing the schema as "the link". According to schema theory,

A schema is a vehicle of memory, allowing organization of an individual's similar experiences in such a way that the individual can easily recognize additional experiences that are also similar, discriminating between these and ones that are dissimilar; can access a generic framework that contains the essential elements of all of these similar experience, including verbal and nonverbal components; can draw inferences, make estimates, create goals, and develop plans using the framework; and can utilize skills, procedures, or rules as needed when faced with a problem for which this particular framework is relevant (Marshall, 1995, p. 39).

According to Marshall, a schema has a network structure. The degree of connectivity among the schema's components determines its strength and accessibility. Such a connection function allows the schema to work together as a unit. The more the connections, the greater the cohesiveness, and the stronger the schema. "Schemas depend on connections; schemas with few connections will not serve an individual as well as schemas with many connections" (Marshall, 1995, p. 180). In the present study, expert coaches made more connections with their previous knowledge, and demonstrated long reasoning chains in motor-skill diagnostic analysis. This might mean that coaches' schemas stored in long-term memory were better connected than those of the novices. Such strong connections may allow them to organize their individual coaching experience in such a way as to relate relevant technique elements from an ideal volleyball spike to a less ideal performance.

Diagnosis and Recommendations

Just as physicians provide treatment for patients after their final diagnosis, coaches need to decide what prioritizing recommendation or intervention they can provide for better performance. According to Knudson and Morrison (2002), a) relationship to previous actions, b) maximizing improvement, c) in order of difficulty, d) correct sequence, e) base of support and f) critical features first are six rationales for coaches to determine what kind of feedback or suggestions they need to tell the athletes. In this study, three of six rationales stood out.

An example from this study is that coaches detected that the hitter's shoulder was leaning to the left. Expert coaches did not just tell the player to stay straight up, instead, they provided suggestions related to the hitter's approaching and take off action, which is before the attacking (arm swing action). This showed expert coaches related their recommendations to the previous action rather than the point where they perceived the problem.

Correct sequence is another rational for coaches to provide their recommendations and feedback according to the proper movement order. Fast sport skills in an open environment (like volleyball spike execution) are highly dependent on preparatory movements. Corrections that emphasize the sequence of the movements might benefit the performance. Expert recommendations from the current study demonstrated this characteristic. Suggestions like "So wait, and stay level and going low to high and explode up" were more sequential rather than focusing on only one single point.

The last rational that Knudson and Morrison (2002) proposed is *critical features first* that coaches provide corrections that relate to the critical features of the movement. "By definition, critical features are the most important factors in determining the success of a movement. They are established by rigorous review of professional experience and research. If the right critical features have been established, correcting them before addressing other general points of good form or style should help the performer achieve the movement goal faster" (Knudson & Morrison, 2002, p. 125). In this study, expert coach two's recommendations were based on a *critical feature first* rationale. In his interview on an ideal spiking technique, he addressed many times the fact that the sequence of the "step close" is one of the most important components for spiking technique. Not only had his recommendations involved this critical feature, but also his diagnostic judgement.

Study Implications and Suggestions

Findings from the current study have several implications for future coach and physical education preparation.

The Importance of Building a Knowledge Base for Motor Skill Analysis

In this study, expert coaches demonstrated a richer knowledge base that contributed to a better diagnostic technique analysis. They identified more critical components related to good form in volleyball spiking. The present study has shown that to be knowledgeable about critical components and correct action sequences can assist coaches and physical educators to discriminate and diagnose performance errors and provide suggestions for skill improvement. The first step in enhancing coaches' diagnostic ability would be building a knowledge base containing information on correct performance sequence, critical features and possible errors of each specific motor skill. A checklist or a criteria sheet was found effective for pre-service students in improving their ability to diagnose errors in a badminton short serve (Pinheiro and Cai, 1999).

Although a quantitative approach, such as a biomechanical technique analysis, can provide useful data-based information, coaches and physical education teachers often choose more practical methods couched in the terminology of the sport that do not require quantitative analysis or extensive expertise in biomechanics. Even Abendroth and Kras' checklist (1999) uses biomechanical terms and concepts not familiar to many practitioners and therefore is not as user-friendly as it could be. A checklist that is oriented more toward qualitative analysis and based more on the diagnostic practice of expert coaches could aid physical education teachers and coaches in improving their motor skill diagnostic performance.

Given a consideration of knowledge about critical components of an ideal volleyball spike identified by experts and data analysis in this study, the researcher developed a checklist for training the future novice motor skill qualitative analysts (See Appendix E). It consists of four action phases. The order of the components in each phase is sequential. The researcher attempted to limit the components to a minimum in order not to overwhelm the novices' information processing capacity. Coaches can adapt this checklist to prioritize the critical components in their own way based on performer skill levels.

Applying Modern Technology to Enhancing Coaches' and Physical Education Teachers' Diagnostic Ability

Applying modern technology by combining videotape and computers technology in novice coaches' and pre-service physical educators' preparation is important in developing motor-skill diagnostic ability. Knudson and Morrison (2002) stated the reason for using technology as one important training tool:

An important tool in extending observational power within qualitative analysis is the use of videotape replay, especially slow-motion replay. Video replay may be most useful in providing information to the analyst that is unavailable to real-time observation. Videotape can capture fast elements of the movement that are unobservable by the naked eye. The greater movement detail and unlimited capacity for replay makes video an important tool for extending the observational power of the teacher or coach within qualitative analysis... Computer programs can even extend and enhance these replay advantages of videotape (p. 200).

Digital camcorders and computer programs that allow videotaped images to be edited and stored in computer or CD-ROM enable both trainer and trainees an easier access to technology in their motor-skill analysis and diagnostic training. The following steps can be used in applying video-computer technique in developing motor-skill analysis and diagnostic ability.

- 1. Select target skill to be analyzed
- 2. Video tape the same performance at different skill levels
- 3. Edit video images and make video clips
- 4. Have students or trainees view video
- 5. Study the critical components of the skill and build up a checklist for skill analysis and diagnosis.
- 6. Study the common errors in performance
- Analyze and diagnose performance by using various technology functions such as replay, pause, slow motion, video-clip comparisons, etc.
- 8. Report findings and provide suggestions for skill improvement.

Recent research has shown that novices can improve visual perception of

movement using specific video training programs (Abernethy, Wood, and Parks, 1999).
In addition, individuals who receive training in diagnosing motor skills are better at motor-skill analysis than those without training (Wilkinson, 1990). Therefore, technology-enhanced training programs could help novice coaches and pre-service physical educators improve their movement diagnostic ability.

Learning from Experts with More Field Experience

Results from this study indicated that expert coaches' diagnostic ability differed from that of novice coaches in many ways. Novice coaches and physical educators need to have more training opportunities to improve their competence in analyzing motorskills. One suggestion is to have students work with experts who are willing to share their knowledge of motor-skill diagnosis within their expertise. There seems to be a need to design a curriculum to provide students with more field experiences under the supervision of expert coaches or teachers. By doing so, students could put theoretical knowledge they have acquired from school into practice. "Adding a semester of internship to a physical education curriculum would allow future physical educators to be better trained in qualitative analysis" (Langendorfer, et al, 2000). For institutions that could not add one semester of internship to a physical education preparation program, increasing time allocation through coursework is another possibility that allows students to improve their skill diagnostic ability. Coursework may include more student observation time allowing students to analyze learners' movement and skill execution under elementary and secondary school physical education settings. Course assignments might consist of analyzing sport performance, working with athletes at different levels, and detecting performance errors by viewing students own performance (by using video tape or video clips).

Further Research Suggestions

Another suggestion that could carry the present research program further is to study expert diagnostic process across other volleyball skills and skills related to other sports. One of the important issues in examining expert coaches' motor-skill analytical and diagnostic ability is to study the strategies applied by the coaches when analyzing sport performance. So far, the questions such as "what are the best visual habits for observing human movement have not been answered (Knudson and Morrison, 2002). By conducting interviews with more experts across different sports on different motor-skill tasks, some common patterns or strategies applied by coaches in their analysis might be discovered.

How a technology-enhanced program impacts pre-service physical education teachers' learning of motor skill analysis and diagnosis is another research topic needed in the future. Although recent innovations in computer technology may help physical education and sport professionals to perform motor skill analysis, research related to the effect of computer-assisted instruction in physical education is inadequate. Additionally, results of the effectiveness of computer-assisted instruction are controversial (McKethan, Everhart, & Stubblefield, 2000). Future research in this area could help develop effective technology-enhanced training programs for novice coaches and physical educators to improve their motor skill diagnostic competence. In addition, a well-controlled research design could provide valid information in the effectiveness of technology-enhanced programs in physical education and sport instruction.

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APPENDIX A

INFORMED CONSENT FORM

Informed Consent Form

I, ______agree to participate in the research entitled "Examination of Expert and Novice Volleyball Coaches' Diagnostic Knowledge", which is being conducted by Wei Bian, School of Health, Physical Education and Leisure Studies, University of Northern Iowa, Telephone (319) 273-3613 and Dr. Paul Schempp, academic advisor, Department of Physical Education and Sport Studies, 375 Ramsey Center, University of Georgia, Athens, Georgia 30602, Telephone (706) 542-4379. I understand that this participation is entirely voluntary. I can withdraw my consent at any time without any penalty and prejudice.

I understand the following points:

1) The reason for the research is to analyze the nature of expertise in coaching sport skills. The benefits that I may expect from it are: first, sharing the research results, and second, having some insight into my own knowledge of teaching and coaching.

2) I understand that I will be asked to do the following things:

a. Fill out a short questionnaire covering my coaching and playing background

information for (Approximately 10 min).

b. Answer questions on volleyball spiking technique and its related components

(Approximately 30 min).

- c. View 4 slides and report what I remember (Approximately 20 min).
- d. Analyze volleyball spiking video clips and provide suggestions and comments for

improvement (Approximately 25 min).

- 3) My individual information obtained from the questionnaire will be known only by researcher. Audio and video tapes will be transcribed and analyzed by the investigator only for research purpose. My name and any details that might identify me will be changed in any written reports in order to protect confidentiality, and audio tapes of the verbal reports, interview transcripts, and written descriptions will be kept in a secured and locked place and destroyed five years after completion of research.
- 4) There will be no harmful use of the data collected in this study.
- 5) No discomfort, stresses, or risks are expected.

6) The researcher, Wei Bian, will answer any further questions about the research, and can be reached via e-mail (bian@uni.edu) or phone (319) 273-3613.

My signature below indicates that the researchers have answered all of my questions to my satisfaction and that I consent to volunteer for this study. I have been given a copy of this form.

Please sign both copies of this form. Keep one and return the other to the investigator.

Signature of Researcher

Date

Signature of Participant

Date

For questions or problems about your rights please call or write: Chris A. Joseph, Ph.D, Human Subjects Office, University of Georgia, 606A Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-6514; E-Mail Address: <u>IRB@uga.edu</u>

APPENDIX B

GENERAL INFORMATION QUESTIONNAIRE

Volleyball Coaches' Study – General Information Questionnaire

Should you need additional space, feel free to use the back of the sheet... Thank you.

Name:	Ado	dress:	
Phone Number:	F	2mail:	
Volleyball Coaching Exper	ience: y	ears.	
Coaching honors and awar	ds won:		
Coaching record:			
Education: Please list all ed	lucational inst	itutions and cert	ification programs attended after
high school and degree/cert	tification recei	ved.	
<u>Institution</u>	Dates atte	<u>nded</u>	Degree/ Certification
Work Experience: Please li	st volleyball-r	elated work expe	eriences.
Employer/Organization	<u>Dates</u>	Position	<u>Full/Part Time</u>

riaying experience: Please be	gin with the year	when you started to play	voneydan
Institution/Organization	Dates	Playing Level	Position

APPENDIX C

TESTING PROTOCOLS

Testing Protocols

You are going to perform the following three tasks for this study. The whole testing process will be video and audio taped for future data analysis. Please provide your verbal report as thoroughly as you can and feel free to ask whenever you have any questions and concerns. I appreciate your support and participation.

Task 1. Interview on an ideal volleyball spike

Could you describe what an ideal spiking technique is?

Please list the components you perceive to be important to an ideal spiking technique. As the components (terms) are mentioned, the researcher writes each one on a separate card and places the card in front of the participant. When the participant feels he or she has listed all the relevant factors, the researcher will tell the participant:

Here are some components you have listed. First, please rate the importance of each component or term that can contribute to a good spiking. You can add or eliminate any component based on your perception.

- 1 = least important
- 2 = somewhat important
- 3 = important
- 4 = very important
- 5 = most important

Task 2. The Recall Test

The next task is a recall test. You will be presented with a series of slides pertaining to volleyball spiking under different game situations. You will view each slide for 10 seconds and then recall what you observed as much as possible. After you have finished your recall about the previous slide, you will be presented the next one. Please take your time.

Do you have any questions?

Let's start.

Task 3. Spike Diagnosis

In the last task, you will watch two video clips of one player spiking a high set from the left front. Clip A is the performance videotaped from back and Clip B is the one videotaped from the side. You can click PLAY icon to view the whole performance. You also can click PAUSE icon to stop the action at any time you want. Or you can move the BLACK DIAMOND to stop anywhere for the analysis. Please take your time.

Your tasks are:

- 1. Provide a general assessment of the player's spiking skill
- 2. Analyze and diagnose the spiking technique
- 3. Provide suggestions on what the player should work on to improve her skill

Do you have any questions? Let's start.

APPENDIX D

CHECKLISTS FOR DATA ANALYSIS

Checklists for Data Analysis

Checklist for the Approach Phase

		Expert			Novice					
		1	2	3	4	1	2	3	4	
Approach										
Veloci	Angle of attack									
ty of										
Appro	Ball position									
ach	& Height of set									
	<u>Transition</u>									
	Position before: dig,									
	defense, block									
	Move outside									
	Start with proper									
	foot									
	<u>Footwork</u>									
	Two to four steps									
	Short to long steps									
	(Tempo of the steps)									
	Left-right-left									
	For right handed									
	See the ball									
	Timing									
	Other									
	Total									

Checklist for the Jump Phase

		Expert		Novice						
		1	2	3	4	1	2	3	4	
Maximum vert	ical height									
(is the goal or t	the result of jumping)									
	Vertical force									
Maximum	Summation of joint									
anaerobic	forces (explode up)									
power	Counter movement									
	(hip loaded, knee									
	bend)									
	Plant foot (step									
	close)									
	Roll heel to toe									
	Push off (drive)									
	Vertical velocity									
	Momentum									
	transition from H to									
	V									
	Directional step-									
	plant									
	Angle with the ball									
	and net									
	Arm swing									
	Upward arm swing									
	during take off									
	Angular									
	displacement									
	Stay behind the ball									
	Pull up—long arms									
	Other									
	Total									

Checklist for the Attack Phase

		Expert				Novice				
		1	2	3	4	1	2	3	4	
	Position at contact									
Accurac										
у	Eye-ball-hand contact									
	Wrist snap									
	Open hand									
	Slap ball									
	Shot selection									
	Arm momentum									
	Angular velocity of									
	arm (pull back elbow)									
	Reach up and forward									
	Truck and shoulder									
	rotation									
	Angular									
	displacement of arm									
	(high elbow)									
	Bow and arrow									
	Throw arm (arm									
	swing)									
	Ball Velocity at the									
	contact									
	Hit at the peak of									
	flight (keep the ball in									
	tront)									
	Other									

Checklist for the Follow Through Phase

			Exp	pert		Novice				
		1	2	3	4	1	2	3	4	
No Foul	Arm swing									
No Injury										
	Pull back (D)									
	Pull down to hip									
	(non-D)									
	Landing									
	Low impact									
	Soft landing									
	Balance									
	Court awareness									
Transition	Next position									
	Square up									
	To net									
	To where hitting									
	Other									

APPENDIX E

CHECKLIST FOR VOLLEYBALL SPIKE OBSERVATION

Checklist for Volleyball Spike Observation

Approach phase:

- Correct footwork: right-left close for a right-handed player and left-right close for a left-handed player.
- Approach and jump angle: for a right handed hitter, spike from an on-hand set (from left side of the volleyball court), approach and take off by facing the setter first and then rotate body toward the net.
- 3. Approach from low to high and then explode up.

Jump phase:

- 4. Heels contact the floor first and roll to toe to transfer the horizontal momentum into vertical height.
- 5. Coordinate arm swing with knee extension to bring the body up in the air. Non-hitting arm leads up while hitting arm bend around shoulder level.

Attack phase:

- 6. Keep elbow high before striking to generate power
- 7. Swing hitting arm fast by using smaller muscles rather than muscles around shoulder.
- Keep ball in the front and hitting arm extended to reach the ball at the highest possible point.
- 9. Contact ball with open hand and snap wrist for topspin.

Follow through phase:

10. Follow through according to set. If the player hits quick set, the follow through should use more forearm function rather than whole arm down to hip. But if the player is an outside hitter, the follow through action should be a full-swing follow up.

APPENDIX F

IMAGES FOR THE RECALL TEST AND SPIKE DIAGNOSIS TASK

Images for the Recall Test and Spike Diagnosis Task

Images for the Recall Test



Slide One



Slide Two

Images for the Recall Test



Slide Three



Slide Four



Video-clip Images for the Spike Diagnosis (Taped from the Back Angle)




Video-clip Images for the Spike Diagnosis (Taped from the Side Angle)

